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Adjuvantibus

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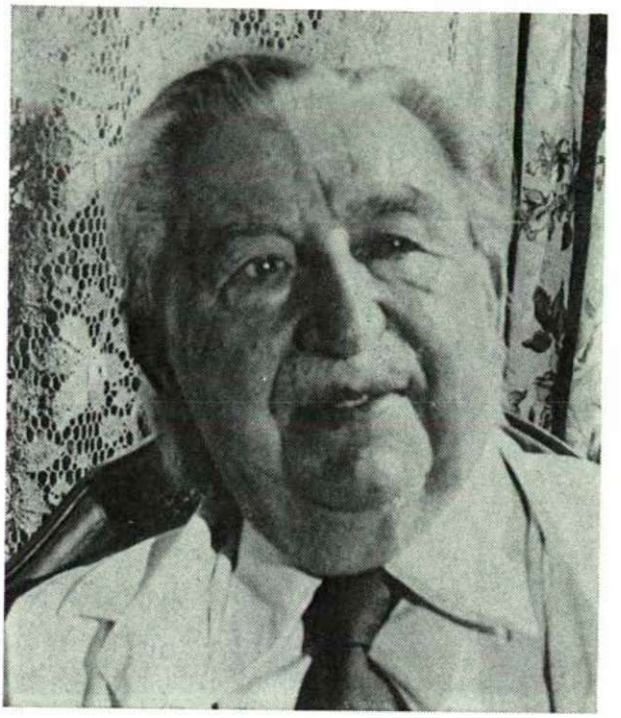

PROFESSOR PÁL GREGUSS IS NINETY YEARS OLD

The editorial board of Acta Biologica Szegediensis has the pleasure to offer congratulations to ninety-year-old Professor PÁL GREGUSS with affection and reverence. Earlier, when he was eighty and eighty-five years old respectively, we already gave a detailed account of his career (Acta Biol. Szeged. 16/1–2 and 21/1–4) characterized by active educational, scientific, pupil-upbringing and science disseminating work. The Department of Botany, where he was head for 25 years, published — as a token of its esteem — the bibliography of Professor Greguss's writings in 1978. His comprehensive scientific, educational and science disseminating and popularizing activity is shown by that list containing 306 books, scientific publications, lecture notes for university and college students, popular science books and other works.

His creative activity is still undiminished, despite his dis advanced age. In the last five years, he brought out eight publications and for the time being five more are in press, contributed to Hungarian as well as foreign learned journals. Not more than a few people know that Professor GREGUSS is not only a prominent biologist but also an art collector. His collection of paintings is particularly precious. His home is a real museum, where besides his various collections the documents of his resp'.ful scientific career can be found.

The editorial board would like to give expression to its high esteem for Professor GREGUSS by publishing fascicules 3–4 of volume 25 as a collection of papers written by a number of Professor Greguss's disciples. At the same time, this is an expression of gratitude on the part of the disciples.

PÁL GREGUSS was born in Tornya, on 31 December, 1889. After completing his elementary and secondary studies, he went on to the Teachers' Training School in Arad where he studied under JÁNOS WAGNER. Since the days of his youth, he took a *kenn* interest in botany and he went to collect specimens to various regions of the country. Even as a student he won several prizes by describing the findings of his collecting field trips.

Having obtained his teacher's diploma, he *pursued* his studies at the Central-School Teachers' Training College in Budapest, under the renowned botanist GUSZTÁV MOESZ. His monograph, "A suriani tengerszemek kovamoszatai" (*Diatoma* of the mountain lakes at Surian) was awarded by the KÁROLY Szilberszki Millenial Prize" by the Association of Natural Sciences.

In 1913, he obtained diplomas as central-school teacher and gymnastics master; then he went on to university in Budapest; in 1914, he joined the army but he made his best, as much as possible, to pursue his tsudies. In 1916, he carried out researches in Prague, at the Pharmacological Institute, under Professor WIECHOWSKY. Also in 1916 he took his doctor's degree at the University in Budapest. At this time, his attention was primarily given to the phylogeny of the vegetable kingdom and in 1918 he published a paper, "Ein Gedanke zur polyphyletischen Entwicklung der Pflanzenwelt."

In 1919, he was appointed lecturer to the Teachers' Training School and, later, to the Central-School Teachers' Training College (both institutions were in Budapest), and there he worked till 1928. During this time, he wrote about 15 textbooks, approximately 40 papers in educational subjects and several scientific publications, as well.

In 1927, the University in Budapest conferred on him a university readership (Privat-Dozent) on the basis of his monograph "A szárnyas növények ivaros szaporodása" Sexual evolution of cauline plants (Cormophyta). A little later, he was appointed lecturer in botany and charged with organizing the Department of Botany at the University in Debrecen.

In 1928, he was appointed head to the Department of Botany of the Central-School Teachers' Training College; in 1940 he became head of the Department of Botany in the University in Szeged and the Director of the Botanical Gardens.

His popular science book, "Növények csodálatos élete" (The wonderful life of plants). It received the honourable title: "The most beautiful book of the year". was published in 1933, his textbook, "Bevezetés az örökléstanba" (Introduction into genetics) in 1935.

His first xylotomical papers were written with reference to Ferenc Móra's excavations; in 1939, he revealed that during the Magdalenian culture fir and cembrapine forests throve in the countryside surrounding Szeged. In his palynological monograph, published in 1940, he gave a description even of the underwood of these forests.

When identifying various prehistoric charcoal fossils, he discovered how difficult it was to identify these, because there was no basis for comparing them. Nevertheless, he wrote, as a first attempt, his monograph, "A hazai őshonos lombosfák meghatá-

rozó kulcsa, szövettani alapon" (A key for identifying the autochtonous deciduous trees of Hungary, on a histological basis) in 1938. From that time on, his interest has been increasingly given to xylotomy. His monograph, "A közép-európai fák és cserjék meghatározása szövettani alapon" ("The identification of central-european dicotyledonous trees and shrubs based on xylotomy") was published in 1945. This book has aroused keen interest abroad as well as at home, and an increasing number of researchers appealed to him for help when it came to identifying some fossilized or carbonized wood remains. Among these identifications, pine fossils caused particular troubles. Consequently, he set himself to investigating into the xylotomy of pines. His thesis submitted to the Hungarian Academy of Sciences for a doctor's degree in biological sciences in 1955 was also treating this problem: "Az élő nyitvatermők xylotómiája" (Xylotomy of the living Gymnosperms). Later, this work was published, too, and it has been used since as a basic reference work all over the world. His monograph, "Holzanatomie der europäischen Laubhölzer" was published in 1959. In 1965, a revised edition was brought out, not only in Hungarian but also in English. His paper, "The phylogeny of sexuality and triphyletic evolution of the landplants"), containing his original theory first published in 1918, attracted considerable attention throughout the world.

He retired in 1965, at the age of seventy-six, but he has continued his researches with undiminished enthusiasm even after-wards. His recent monographs are the following: "Fossil Gymnosperm Woods in Hungary from the Permian to the Pliocene" (1967) "Xylotomy of the living Cicads" and "Einführung in die Paläoxylotomie", both published in 1968; "Xylotomy of the living Conifers" (1972). In addition to these monographs, he contributed several scientific papers to Hungarian as well as foreign learned journals.

The number of Professor Greguss's works is over 300. 25 of these publications are books. His exceptionally rich interests have covered several branches of the biological sciences and created in more than one field works of permanent value. He published 5 monographs in natural philosophy, 12 in plant physiology, 15 in external morphology, 41 in plant histology, 5 in botanical taxonomy, 3 in plant geography, 30 in plant phylogenetics and theory of evolution, 10 in genetics, 58 in palaeo-ontology, 5 in palynology, 8 in plant ecology. The number of his various school and university textbooks and lecture notes is 36. He has performed a widespread science disseminating and popularizing activity, as well, with 25 papers published in this field. In 1979 was published his lengthy autobiography "My Life" in Hungarian.

Professor GREGUSS has met with a well-deserved and widespread recognition. In 1956, he was conferred a doctor's degree in biology by the Hungarian Academy of Sciences. In 1955, 1959 and, for the third time, in 1965, the Government of the Hungarian People's Republic awarded him the golden grade of the Order of Labour and nad in 1958, the silver grade of the Kossuth Prize. He received 6 gold, 5 diamond and 3 iron pedagogical-diplomas, too. He was twice pro-dean and once dean of the Faculty of Natural Sciences of the University in Szeged and, for one term, he was Rector of the same University.

Professor GREGUSS is the honorary member of several Hungarian and foreign learned societies. He has been and is even now in close and far-ranging scientific connection with more than 600 researchers. Hungarian as well as foreign experts have named a number of living and fossil plants after him.

Besides his very substantial scientific and educational activities, Professor GREGUSS managed to set up a Department of Botany at the University in Szeged, reorganized the Botanical Gardens of the University and made it well-known all over the world. From among his many hundred students, some became University or College professors, readers, and doctors and candidates of the Hungarian Academy of Sciences.

* * *

The editorial board of Acta Biologica Szegediensis wishes Professor PÁL GREGUSS to continue his creative scientific activity for many years to come, to instruct and educate young people and to come every day to visit and to work at the Department of Botany where he was head for 25 years.

† Prof. Dr. I. HORVÁTH
head of department

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NEW CHLOROCOCCALES SPECIES IN THE DANUBE HYBRID ALGAE?

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(Received February 18, 1979)

Abstract

Three new Chlorococcales species, observed by the author in the Budapest reaches of the Danube, are reported on: *Actinastrum mixtum* HORTOB. n. sp., *Micractinium extremum* HORTOB. n. sp., *Tetrastrum nonsens* HORTOB. n. sp. The supposition of hybrid character is justified by the appearance of all the three organisms.

The coenobia of *Actinastrum mixtum* HORTOB. are built of cells of two types. One of the cell types agrees with the cells of *Actinastrum gracillimum* G. N. SMITH, the other with those of *Actinastrum aciculare* PLAYF.

Micractinium extremum HORTOB. combines the characteristics of *Micractinium pusillum* FRES. and of *Micractinium crassisetum* HORTOB.

On the cells of *Tetrastrum nonsens* Hortob. the characteristics of *Tetrastrum parallelum* Hortob. and of *Tetrastrum staurogeniaeforme* (Schroed.) Lemm. can be observed.

Although the most characteristic way of the reproduction of Chlorococcales is the autospore-sormation, zoogamy also occurs in some genera. And by this the possibility of hybridization is fupported.

Hereinafter, the description of three new species is published, in respect of whose origin the question may come up, if they aren't hybrid descendants.

Actinastrum mixtum HORTOB. n.sp.

(Figs. 1–5)

In the reaches of the Danube at Budapest, on 28 August, 1974, at river kms 1586 and 1608, as well as on 16 September, 1975 at river km 1643, it did not belong to the rare algae. In August, the temperature of water was 20.8 °C, pH 7.85; in September, water temperature was 16.5 °C, pH 7.96.

The cells have two kinds of shape: half of them are straight or very slightly curved rods; about their ends they may be somewhat narrower, their ends being broadly rounded. The other half of the cells of coenobium are widely rounded at their lower part, towards their peak they become gradually thinner and thinner and pointless. These cells are more rarely straight, they are mostly slightly curved. The rod-shaped and elongated drop-shaped cells are alternately present in coenobia. The length of cells is 12.5–31 μ, their width is 1.4–2.6 μ. The cells are quite or almost quite filled by a large chloroplast, which is parietal contaning a well-developed pyrenoid. At the contact of cells, a larger or smaller cavity is formed.

It sometimes occurs that the cells of two shapes cannot be observed alternately but two cells of identical type can be found beside each other, as seen in Figure 4.

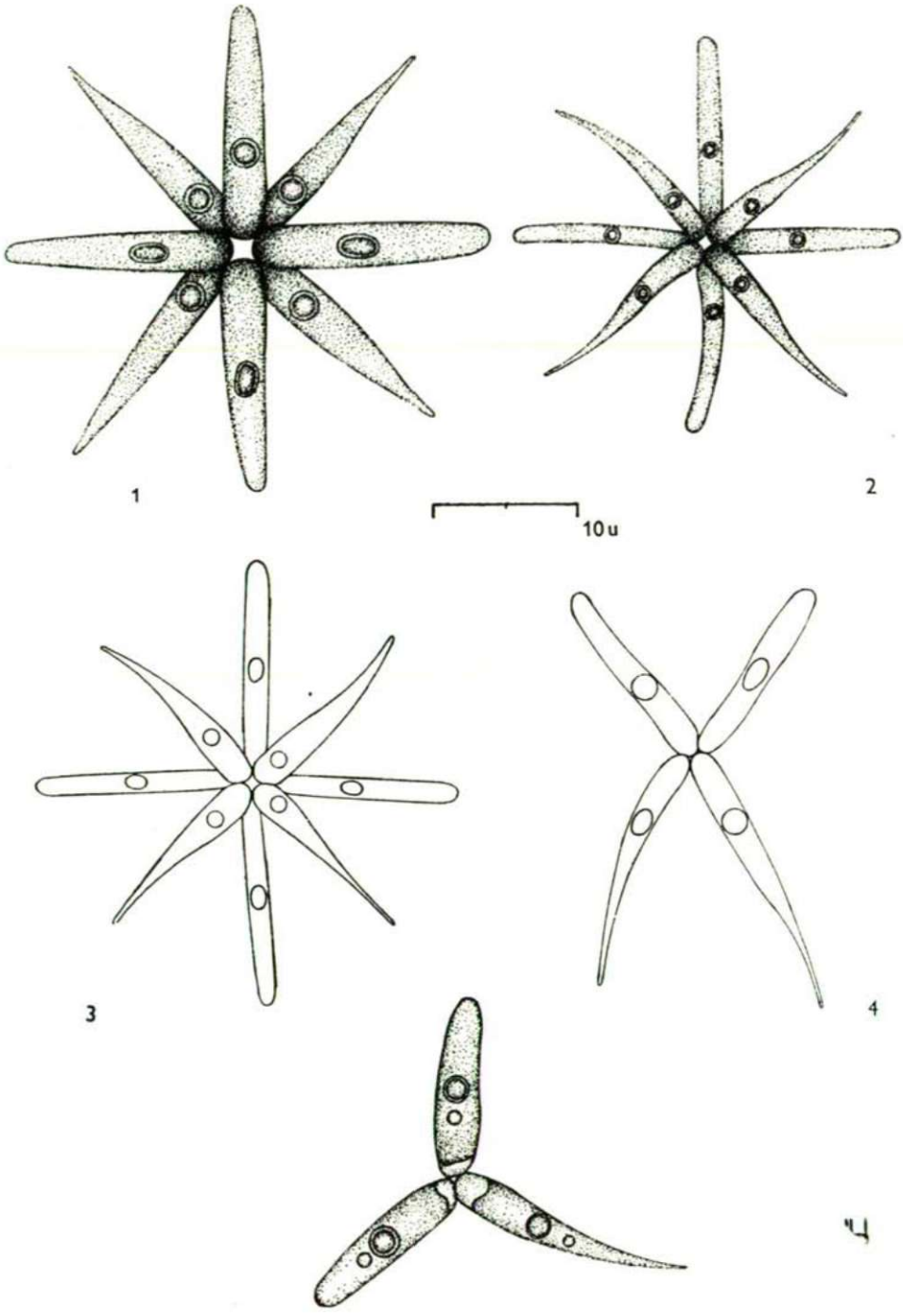

Fig 1—5

The cells in the coenobium are rarely of odd number. In this case, there is more of one of the cell types, like e.g. in Figure 5.

The new species differs from every *Actinastrum*, known so far, in its two kinds of cell shape. The blunt-ended cylindric cells are entirely identical with the cells of *Actinastrum gracillimum* G. M. SMITH, while those becoming thin correspond to the cells of *Actinastrum aciculare* PLAYF.

On 28 August 1974, there was a rich phytocoenosis in the Danube, with a large number of litres and many kinds of taxons. Green algae took quantitatively part in 60 per cent, dieatoms in 37 per cent, at river-km 1586. From among the green algae, *Ankistrodesmus, Actinastrum, Hortobágyiellae, Dictyosphaerium, Coelastrum, Scenedesmus, Chlamydomonas*, and from diatoms *Stephanodiscus* were characteristic. At river-km 1608 a similar association developed.

On 16 September 1975, at river-km 1643, in a quantitative sequence, diatoms, blue-green algae and green algae dominated. From the blue-green algae *Achroonema, Romeria*, from the green algae the above mentioned ones and *Hyaloraphidium* are characteristic. *Planctomyces* also present themselves in a considerable number

Micractinium extremum HORTOB. n.sp.
(Figs. 6–7)

It was found in a water sample from 26 May 1976, close to the left bank of the Danube, at river-km 1630. It is rare. The pH of water was 7.82.

The thalluses are, as a rule, 8-celled, the cells stand cluster-like, they are of spherical form, their diameter is 5.2–6.4 μ, linking up closely with one another, but preserving, nevertheless, their regular spherical form. The spines are thin and pointed as a pin, or they are thick and similarly end in a fine point. There always occur only one or exceptionally two spines in a cell. These are either thin or thick. They can never be observed mixed. The length of thin spines may reach 30 μ, that of the thin ones 52 μ. The thin spines are 1 μ wide at their base, the width of the thick ones is 3–4 μ at their base. In each cell a parietal chloroplast is formed, containing a well-developed pyrenoid.

This combines the properties of *Micractinium pusillum* FRES. and *Micractinium crassisetum* HORTOB. In the former only thin spines are formed, in the latter only thick ones.

On the cells of *Micractinium strigoniense* HORTOB. the thin and thick spines can be found. On one cell, however, both kinds of spine occur, arranged regularly in such a way that the thick spines coming from about the middle of the cell are accompanied, from right and left, by a thin spine each, much smaller than the thick spine.

In the days of collecting, the phytocoenosis was characterized by Bacillariophyceae: they were present in 95 percent. The participation of Chlorophyceae is not more than 4.3 per cent. The number of Cyanophytons is very low: 2 percent. Caulobacteriales were the remaining 0.5 per cent. The most characteristic and frequent alga was *Stephanodiscus Hantzschii* GRUN.

In the time of collecting, both *Micractinium pusillum* FRES. and *Micractinium crassisetum* HORTOB. were present. Hybridization could, therefore, take place.

Tetrastrum nonsens HORTOB. n.sp.
(Fig. 8)

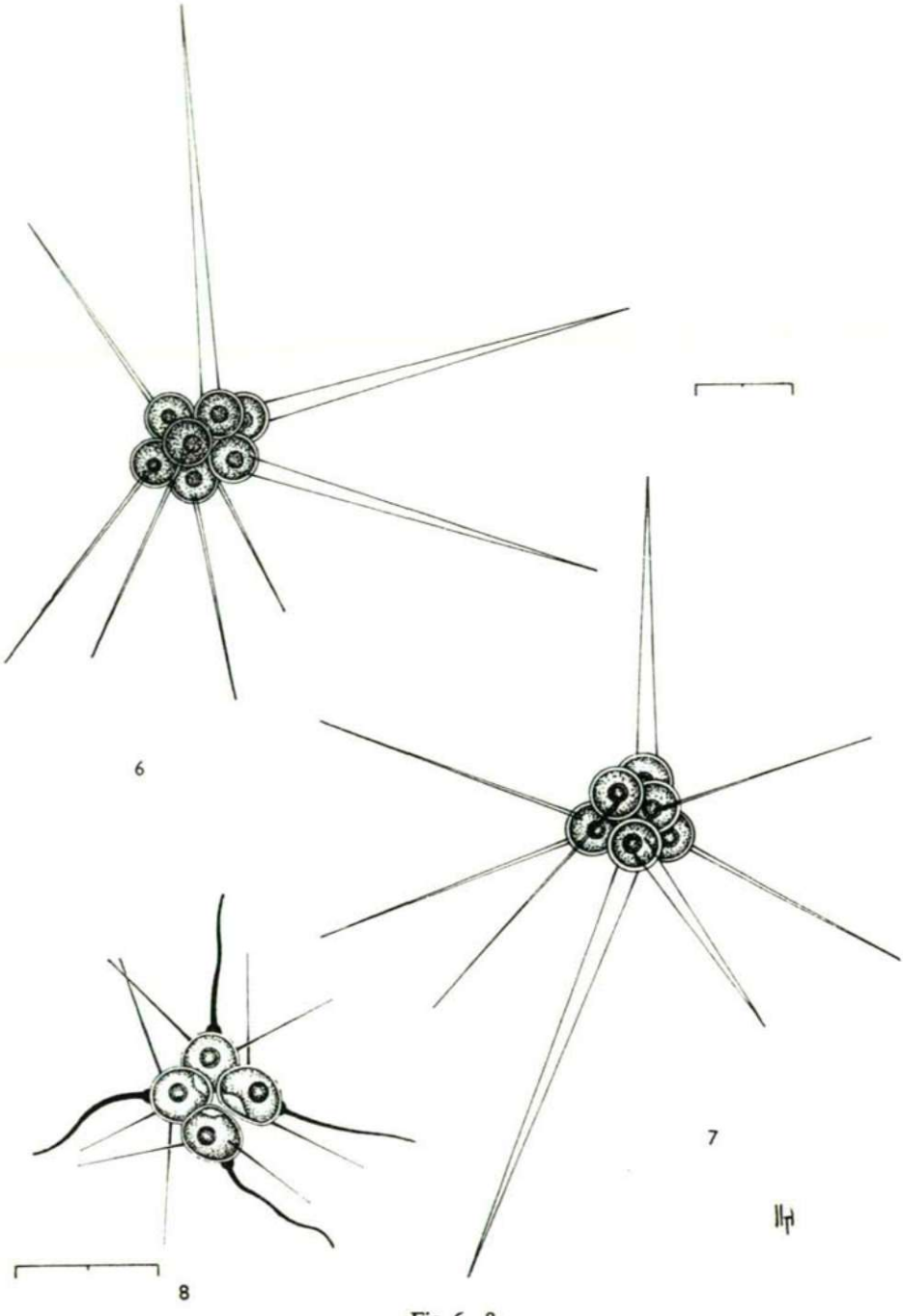

Fig 6—8

This organism was found in the collection of 9 May 1974, at river-km 1608; pH: 8.06. It belonged to the very rare algae.

Cells may be spherical, globular or a little compressed. Their diameter is 4–4.6 μ. In the coenobia they take place in fours, hold fast to one another, yet touching each other at a small surface. They are not always at the same level. In the parietal chloroplast a well-developed pyrenoid is to be seen. The lumen is almost filled in fully with chloroplast. From the part of cells looking outwards two kinds of spines originate. One of the types is represented by the spine standing in the axis of cells, one of them taking place in each cell. This is thick, curved or wavy, becoming somewhat thinner at the peak, and ending in a blunt point. Its lower part grows wider hemisphere-like, it sticks with this to the cell. The length of the thick spine is 9–11 μ. To the right and left from this thick spine, one or two straight, thin spines develop which are somewhat shorter, pointed as a pin, becoming hardly thick at their forming a joint with the cell. Their length is 6.5–8.8 μ. The shorter, straight spines have no spine base.

Tetrastrum nonsens HORTOB. combines the properties of *Tetrastrum parallelum* HORTOB. *Tetrastrum staurogeniaeforme* (SCHROED.) LEMM. To the former a thick, curved-wavy spine of blunt point and wide base refers, to be seen in each cell, taking shape in each cell at the *parallelum*, at the axis of cells. Of the latter alga, the thin, straight and very much pointed spines — to be observed at the species described now, on the right and left from the thick spine — remind us.

Tetrastrum nonsens HORTOB. was a member of a poor coenosis in May, 1974, only Bacillariophyceae appearing in a higher taxon-number. They formed 85 per cent of algae, most of them being *Stephanodiscus Hantzschii* GRUN.

Hybridization is possible, because both the algae *Tetrastrum parallelum* HORTOB. and *Tetrastrum staurogeniaeforme* (SCHROED.) LEMM. occur in the Danube.

The most characteristic way of the multiplication of Chlorococcales is forming autospores. In addition, in the families Palmallaceae and Coccomyxaceae also reproduction by fission is to be found. The possibility of hybridization is supported by that we also know of zoogamy, taking place by means of the copulation of gametes in more than one genus, like e.g. *Pediastrum, Hydrodictyon* (BRAUN, 1855), *Micractinium* (KORSCHIKOV, 1937), *Golenkinia* (KORSCHIKOV, 1937), *Dictyosphaerium* (IENGAR and RAMANATHAN, 1940), *Scenedesmus* (TRAINOR and BURG, 1965), *Eremosphaera* (KIES, 1967), *Chodatella* (RAMALEY).

It is highly probable that the existence of a number of Chlorococcales taxons is due to hybridization.

Diagnoses

Actinastrum mixtum HORTOB. n.sp.
(Fig. 1–5)

Coenobia 4-, vel 8-cellularis, e cellulis diversiformibus: rectis vel lenissime inclinatis, cylindricis, versus apices forte parum tenuiescentibus et subtus latis deinde gradatim tenuiescentibus, apice obtusis, rectis vel parum inclinatis, 12.5–31 × 1.4–2.6 μ magnis, alternatim dispositis constructa. Chloroplastis unicus, basin cellulae non semper attingens, pyrenoidam unicam, bene evolutum habens.

Fig. 5: coenobium abnormale: tricellulare, duae cellularum cylindricae.
Danubius, VIII–IX. 1974. — Non rare.
Cellulis diversiformibus ab omnibus speciebus generis Actinastri distinctum.

Micractinium extremum HORTOB. n.sp.
(Fig. 6–7)

Thalli pelumque 8-cellulares, e cellulis arcte dispositis, 5.2–6.4 diam., compositis. Spinae 1–2 aut tenues, aut valde crassae in unaquaque cellula. Spinae tenues usque ad 30 μ, crassae usque ad 52 μ longae. Pyrenoidae pro cellula singulae, conspicuae. Chloroplasti singuli, parietales.

Species haec nova nostra notas et *Micractinium pusilli* FRES. et *Micractinium crassiseti* HORTOB. ad instar hybridae in speciam colligens. — *Micractinium strigoniense* HORTOB. per dispositionem regularem spinarum mixte tenuium crassarumve in unaquaque cellula distinctum.

Danubius, V. 1976. — Rare.

Tetrastrum nonsens HORTOB. n.sp.
(Fig. 8)

Cellulae 4–4.6 μ diam., blobulosae, parum compresse, forte paene triangulares, non semper in uno plano dispositae, in polis spinis singulis, crassis, inclinatis vel undulatis, obtusis, ad basin dilatatis, 9–11 μ longis, in duobus lateribus earum spinis singulis, rarissime 2, brevioribus, 6.5–8.8 μ longis, rectis, gracilioribus, mucronatis, ad basin non dilatatis ornatae. Chloroplastis unicus, cellulam paene implens, in eo pyrenoida bene evoluta.

Danubius, V. 1974. — Rarissime.

Tetrastrum parallelum HORTOB. et *Tetrastrum staurogeniaeforme* (SCHROED.) LEMM. ei proxima. Species nova nostra a *Tetrastro parallelo* spinis tenuibus acutis, a *Tetrastro staurogeniaeforme* spinis singulis, crassis, obtusis, inclinatis, ad basin dilatatis polarum distincta.

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ALGOLOGICAL AND HYDROLOGICAL INVESTIGATIONS INTO ALKALI SOILS, WITH PARTICULAR REGARD TO THE PROBLEMS OF WATER UPRUSHES AND "VARIETY OF COLOURS"

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Abstract

A characteristic peculiarity of the alkali soils in Hungary is the "variety of colours", the mosaic-like heterogeneous character. That is to say: the physical, chemical and biological peculiarities of the soil may change within comparatively small distances. On the basis of our algological and hydrological investigations, carried out for several decades, we see so that this is in connection, in a very high degree, with the different forms of the water uprushes which have less been investigated, until now. The spotted water uprushes are coloured with remarkable algal mass-productions. In this paper, some water-uprush forms of algal mass-productions are discussed from the dried-out bed of the central lake Fehér-tó of Kardoskút-puszta in County Békés and its environs.

Introduction

I have dealt with the algological investigation into the home alkali waters for 50 years. In my younger days, I have walked much on the alkali soils of my native land and I wanted even to be an agriculturist. I have therefore, received with great joy Professor Pál Greguss's suggestion in 1929, to deal — as a subject of my diploma work — with the algological investigation into the alkali waters at Orosháza. My diploma work was made for the assigned date (Kiss, 1933). I continued my investigations and my doctoral thesis was also published from the same domain (Kiss, 1939). An now, remembering this, I am presenting this work of mine to the 90 years anniversary of Professor Greguss's birth. In addition, I have dealt from 1934 with the algae of alkali soils, as well. I was particularly stimulated to this by the agricultural scientists Imre Török and Lajos Kreybig, providing for me also an opportunity to do this as a junior lecturer in the Department of Agronomics of the Teachers' Training College in Szeged. Further on, this has proved to be very useful.

At my summer research trips in the environs of Kardoskút, Békéssámson and Mezőhegyes, on the fawn-coloured "burned out" grass of the dry pastures I often observed fresh-green grass spots of moist soil. In the environs of Kakasszék and Kardoskút-Puszta-Centre, my attention was even more drawn to the drying-out lake-beds, from the greyish-white terrain of which the dark and muddy spots of the water spouts could already be seen well from far away. These were often coloured by algal mass-productions, as well. On the ground of an old agricultural tradition, these spots have — not inaptly — been called "springs" or "springlets" by people there. This term generalizes the observations of some centuries and it seems worth taking this into consideration in the specialized branch of science, as well.

During the past five decades, I surveyed the considerable enough alkali areas of Hungary. I have visited in the territory east of the river Tisza 60, in the region between the rivers Danube and Tisza 73, along the rivers Bodrog—Zagyva—Tisza 3, and in Transdanubia 19, i.e., totally 155 alkali waters, lakes and investigated into these from algological point of view. I have everywhere sought for the phenomena of water uprushes but the most typical ones of them proved, so far, to be those observed in the environs of Kardoskút and Békéssámson. It is true that I have investigated into these regions for long decades. To the water uprushes at Kardoskút those of the lake Kelemenszék-tó on the western confines of Fülöpszállás, as well as those of the lake Sós-tó at Sárkeresztúr are the most similar (KISS, 1976a; 1976b). They are worth while to be investigated further on.

Concerning water spouts, I have found two interesting series of data in the home special literature (KISS, 1976a; 1976b). MADOS wrote an appreciation of the importance of hydrological conditions in soil research. According to him, "Scherf's theory concerning the origin of the bulk of salts, the co-operation of soil water, and generally from geological point of view, may be qualified as absolutely acceptable but without Sigmond's explanation of phenomena it is not complete." His following statement is particularly important from our point of view: "It is undeniable that the soil water under pressure can break through the bas aquiferous layer even in a period when it already became impermeable for rainwater. In this way, salts can get into the upper soil and there will be no opportunity later any more to leach it below the layer becoming impermeable". He establishes further on that "... the rising of salts by the subsoil water and the eluviation of the soil in alkali medium, as a phenomenon conductive to alkalization, don't contain any contradiction but they give even together the full explanation of the course of alkalization". In the fundamental book of ARANY, I have found references to water spout in two places. He mentions on page 156 of a characterized place: "Partly the configurations of the surface of its terrain, partly the position of the sub-soil layers are such that not only the surface water assembled together upon them but their subsoil-water stood very high, as well, and even it rushed up on the surface, too." On page 157, he writes of the area which stood under water before: "The surface water ran here, for the most part, from the adjacent higher lying regions, to the deepest-lying part of the environment, and, at the same time, the underground water-level sometimes stood so high that it got to the surface."

The phenomena a water spout, described by me from the environs of Kardoskút and Békéssámson (KISS 1959; 1963; 1968; 1969; 1970a; 1970b; 1971a; 1971b; 1971c; 1972a; 1972b; 1974; 1975; 1976a; 1976b) may be reconciled well with the hydrological researches relating to the subject (RÓNAI, 1956). Rónai has ascertained that the most developed zone of high subsoil water of the southern territory east of the Tisza extends north-west from Dombegyháza towards Orosháza, then from there to the south through Békéssámson until the environs of Csanádalberti. The underground-water level lies here 1–2 m deep below the surface. In the province Alberta of Canada, hydrogeologist J. TÓTH described some water-spout phenomena, very similar to those at Kardoskút (TÓTH, 1966; 1969; 1971). He mentions that people there also know the water spouts called "springs", "springlets" at Kardoskút and call these "soap hole", "mud spring" or "mud volcano", according to their differences. He demonstrates these with coloured photographs, as well

The hydrology of water uprushes, their forms and role in the "variagation" of alkali soils

Our home alkali soils are characterized by a spotty "variety" of colours. The essence of this is that within comparatively small distances, sometimes almost step by step, the physical, chemical, biological and other properties connected with the level may change. About this, I have earlier formulated the following opinion (KISS, 1969): *"In all probability, we are not far from reality supposing that the spottily disproportionate distribution of the subsoil water belongs to the basic nature of alkali soils and that the phenomenon of spotty variegation is mostly in connection with the spottily disproportionate distribution of subsoil water"*. It can also be told briefly: *the "variegation" of alkali soils is a consequence of the "variegated" water conditions.* As, anyway, the disproportionate water conditions are brought about by the open and concealed forms of water uprush, *the phenomenon of water uprush is the central problem of the hydrology of alkali-variegation.* The essence of water uprush must, therefore, be interpreted.

Essence and forms of the water uprush

If at some spot the subsoil water rises close to the surface or until the surface, water uprush comes about. In this, the capillary water motion has some part but the primary cause is much more that the water moving in the different ducts is under a pressure from below, mainly a hydrostatical pressure, rising the subsoil water through the water-sealing layer, in repeated rhythms towards the surface. And the unequal water-conductivity of soils, soil layers, in case of the soils beginning to be alkalized, may originally be attributed to that the accretion of the one-time water-courses occurred unequally, in a "disturbed" way. *The unequal siltation masses up some layers upon or beside one another more or less water-conductive or water-sealing layers, conducting the water towards the surface spottily, unequally.* In the subsoil, there are also *water-conducting ducts, "rills"*. This similarly contributes to bringing about or increasing "variability". We have observed that the unequal water pressures may from time to time even change somewhat their places. By this, the picture of soil structure or soil composition, induced already before, can repeatedly be modified. It was only by supposing this that we could explain the fact that the terrain, created by river siltation and alkalization, is composed of spots, differing from step to step from one another. Interpreting the alkali-variety, the results — apart from paedology and agrochemistry — also of geology and hydrology ought to be integrated. To the first approximation, the two latter ones are necessary, too.

In the following, I will present a few cases of the water uprushes, observed on the confines of Kardoskút—Puszta-Centre and Békéssámson, classified in some main forms. These will sometimes be completed with those observed in other alkali lands, too.

Main form I:"Spring"-wells or overflow wells

At the southern side of the lake Fehér-tó at Kardoskút, the well of Farkas's farmstead may be considered as a "classical" example (Fig. 1). At the end of Winter, the cavity of this is completely filled with water, rusing up from 2–3 "rills", sometimes so much that the water runs out under the brim of well, resp. through the leaks

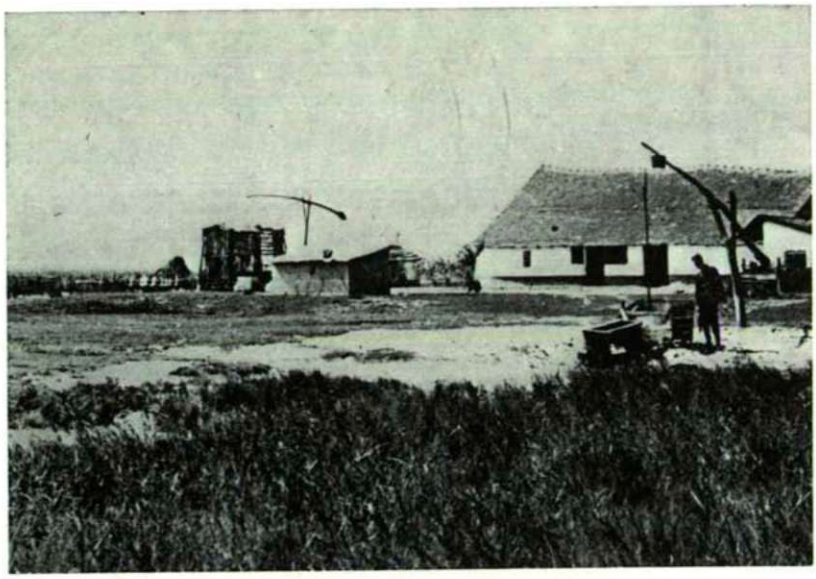

Fig. 1. Overflow-well in Kardoskút-Pusztaközpont, in the farm-yard of the farmstead of István Farkas. From the full basin of the well, water runs into the lake or the dips of the yard per Springs.

of the 1–2 upper rows of bricks of the well-lining, into the deeper-lying lake. In some years, this runningout incessantly endures till the beginning or middle of Summer. Now and then we also measured the water production of the well approximately. We scooped out of the well 10–12 pails of water and observed, during what a time it will be supplied. On 9 May 1962, e.g., about 6–8 l water ran out per minute, on 29 May about 3 l, and on 10 August already hardly 1 litre. But even in this way, during a few months much more than 100 cc.m water could get into the lake. Later on, the height of the well above the level of the Adriatic was measured by the head of the department, VÁGÁS, and since then, the water production of the well has continuously been recorded. In 1942, on the occasion of the inland waters of inundation character, some wells like this were also observed by KREYBIG in the area of the loess banks of the Békés—Csanád region. In 1935, in the steppe Eperjes-puszta, north of Orosháza, I myself also saw a "spring"-well, corresponding to that in Kardoskút, in the farm-yard of the then Traum's farmstead. In 1973, in the region of Hungary beyond the Danube (Transdanubia), at the fringe of the village Sárkeresztúr, I also heard of a well like this. The occupants of the house No 1 of Imre-major reported on their well that it "overflows" every Spring. The water of these wells is fit to drink.

Main form II: Remarkable water uprushes in the dry basin of the lake Fehér-tó

We have investigated from algological point of view dozens of water uprushes in the dried-out basin of the lake Fehér-tó at Kardoskút. The surface of the dry basin is covered with a greyish-white "efflorescence". This is partly salt, partly

dehydrated silicic acid, originating from the decomposition of the adsorptive complex. The pH of this crusty and later dust-like "desintegrating" basin surface mostly fluctuated between8.5 and 9.2. The total salt content of the condensed water of the lake is very important. According to Szépfalusi's analyses, for instance, at Farkas's farmstead, in July 1963 20,000 mg/l and in July 1964 40,000 mg/1 total salt content was observed. The alkali character of the lake Fehér-tó also comes from the too large quantity of natrium hidrocarbonate. The Na^+ amount can increase to the value 32,000 mg/l in a water condensed at the middle or end of Summer. At the same time, the amount of hydrocarbonate may exceed the value 9000 mg/l, as well. The carbonate content may rise over the value 4000 mg/l in mid-July and the chloride content then already also exceeds the value 1500 mg/l. The chloride value was outstanding on 6 July 1963 when in the condensing water a quantity of 4000 mg/l was demonstrated by analysis. Sulphate is also considerable; until Spring it is 140 mg/l; in Summer, however, it is less. The water is surface water, in respect of cation with natrium-magnesium, and in respect of anion with carbonate-hydrocarbonate-chloride (SZÉPFALUSI, 1963). The ratio of cations and anions is not everywhere alike; this particularly turned out from the fluctuation of the relation between Ca^{++} and Mg^{++}. In the water samples, collected in the area close to Farkas's farmstead, the fluctuation of these cations is of definite character; more to west, towards Czuczi's farmstead, however, Mg^{++} always dominates. The phenomenon of spotty "variety" manifests itself, therefore, here, too, which can be reduced to the spotty differences of the soil, resp. to the partial promotors of these, the water uprushes. The everywhere appearing "variety" must obviously be connected with the geological past of this area, as well. According to MOLNÁR and MUCSI, the present-day lake basin consists of two ancient river-bed parts and the history of the latter ones has differred since the Pleistocene (MOLNÁR, MUCSI, 1966). The western part of the lake is — according to our investigations much richer in water uprushes. Here the water of the well in Czuczi's farmstead has a pH-value at least a few decimals higher than the water of wells being towards east, in Farkas's farmstead.

A searching chemical analysis of the soil of spots with water rushes might similarly manifest a further "varied" picture. The different places of the same spot can namely differ from one another in respect of pH, as well. In the marginal parts of spots is, namely, the pH-value mostly higher. In the following, we display a number of plots.

1. A spot with a muddy water uprush (Fig. 2)

Date of observation: 2 October, 1961. The pH of the surface at the marginal parts is 9.3. The 3×2 m large area is of slipperily muddy surface, sharply delimited from the adjacent dry lake basin of greyish-white "efflorescences". It is visible in the picture, too, that the muddy surface slightly bulges. At the lower margin of the picture, the initiatives of fissures originating from the loss of water are well perceptible. In these, sometimes, water was still shining. By this is shown, too, that the pressing-up of water to the surface ceased to be 1 or 2 days earlier. The spot was, almost in its whole extent, brownish-green and it had sporadically a strongly glistening surface. The colouration was induced by the mass production of algae

Fig. 2. A somewhat bulged, dark and muddy stain of water-uprush in the extincted lake-bed of the lake Fehér-tó at Kardoskút. Its surface is stained by algal mass-production.

and the glissening by the appearance of colloidal matters of greasy touching. The algal species of the mass-production are as follows:

1. *Gloeocapsa turgida* (KÜTZ.) HOLLERBACH
2. *Coccopedia limnetica* TROITZK.
3. *Anabaena variabilis* KÜTZING
4. *Oscillatoria Lemmermanni* WOLOSZ.
5. *Oscillatoria brevis* KÜTZING
6. *Pelonema* spec. *(*of larger size then *P. pseudovacuolatum*!*)*
7. *Phormidium papyraceum* (AGARDH.) GOMONT
8. *Gongrosira trentepohliopsis* (SCHMIDLE) var. *natrophila* KISS. I.

In the algal mass the remains of flint shells could also often be seen but on the basis of these the here-found Bacillariophyceae species could not be determined.

2. Dry spot, with already "disintegrated" water uprushes (Fig. 3)

Date of observation: 22 September, 1963. The pH of the mouldering substance of the soil surface is 9.5; in the environs only 9.00. The length of the spot of long drawn-out elliptical shape is 5.3, its width is 1.7 m. This is of surface, already granularly disintegrating because of becoming dry. Its colour is clearer than that of the adjacent lake basin which is similarly granularly-dustily disintegrating. In the spot the salts, resp. the dedydrated silicic acid may be present in a rather large quantity. This spot also protrudes a little from the terrain. The dry lake bottom is covered

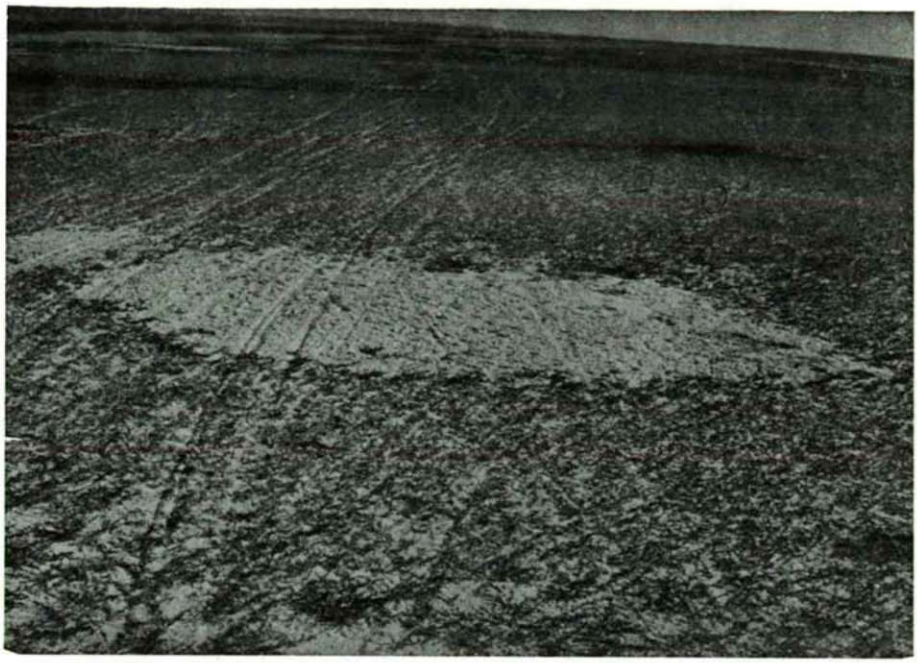

Fig. 3. A granulously bulging "blind-alkali" stain, covered with dust, in the bed of the lake Fehértó at Kardoskút, resuline from the extinction of a stain of water-uprush. Here and there, its surface is stained by algal mass-production.

with the stands of *Suaeda maritima* (L.) DUM. ssp. *prostrata* SOÓ. The spot with water uprush is, however, "blind-alkali". Here the formation of macrovegetation may have been impeded partly by the crumbling, partly it is here and there of "rummaging" character. In some places of the blind-alkali — regradation spot, palm-sized or smaller algal mass-production spots appeared. These may have been the remains of an earlier, more uniform "soil blooming" (flos humi). Two spotlets may even be seen at the right margin of the picture. On the place of the algal mass-production spots the soil surface is less disintegrated into a granular-dusty substance. Under such a surface, remaining compact, in a depth of 2–3 mm, a newer colouration could be observed, the crypto-vegetative mass-production of algae. About 1–1.5 cm deep, the area below the cloddy-granular crumbling was also slightly coloured, as a result of the further spreading of the cryptovegetation. The constituents of the algal flora are:

1. *Gloeocapsa minuta* (KÜTZ.) HOLLERBACH
2. *Oscillatoria brevis* KÜTZING
3. *Lyngbya Martensiana* MENEGH.
4. *Gongrosira trentepohliopsis* SCHMIDLE var *natrophila* KISS. I.

This crumbling spot reminds us, to a certain extent, of the alkali spot that is shown in Professor ARANY's book, in picture 12, about the sand in Nyíregyháza. The question is, how many are the common traits in the formative processes.

3. Spots of water uprushes with *Bolboschoenus maritimus* stands (Fig. 4)

Date of observation: 28 September, 1958. The spots of water uprushes overgrown with *Bolboschoenus*-stands, have lined up, and do this mostly today, as well, mainly in the southern part of the western half of the lake, close to the lake-side. The spots are of irregular form, their diameter may be from 2–3 m even till 15–20 m. The most conspicuous trait is, here too, that the surface of the soil is wet, sometimes even boggy, but the surfaces of the bottom of the lake without water uprushes are entirely dry and creviced. It is well-visible in the picture that the spots of water uprushes somewhat bulge from the terrain, as if cushioned; with their entirely unbroken surface they are sharply delimited from the places of the bottom of the lake, full of crevices and without water uprushes. The vegetation covers, as a rule, the middle part of spots. The pH-value fluctuated between 9.3–9.7 in the spots of water uprushes. In other parts of the bottom of the lake, the pH was of some decimals less value. The surface of the at least moist-wet spots is covered with algal mass-productions. The nuances change even within the single spots what refers to the

Fig. 4. In the bed of the lake Fehér-tó, on the stains of a water-uprush, the thalli of *Bolboschoenus maritimus* appear in some places. On the fringe of vegetation it is visible that the smooth surface of the ground shaprly differs from the crevassed surface of the lake-bed.

differences in composition of the constituting algal populations. In the spot on the left of the foreground of the picture the following species were found:

1. *Oscillatoria brevis* KÜTZING
2. *Phormidium foveolarum* (MONT.) GOMONT
3. *Phormidium fragile* (MENEGH.) GOMONT
4. *Phormidium tenue* (MENEGH.) GOMONT

Algal samples were taken from 10 spots together. Among these there were some populations much richer in species but the former four species occurred in all of them. Similar species covered with *Bolboschoenus* stand also occurred on the confines of Sárkeresztúr and in the basin of the lakes Sós-tó, Nagyvadas-tó and Fehérszik-tó at Tiszavasvár. Particularly, the spots of water uprushes on the bottom of the lake Fehérszík-tó were swampy most usually. It occurred that here, on one of the spots, a foot of one of us sank in the mud about 40 cm. At any rate, the surface of spots is, as a rule, not boggy. Some algal mass-production occurs in case of all of them but not with an identical algal flora. These, however, cannot be treated here at length.

Main form III: Hidden water uprushes on a higher terrain

Water uprushes can develop not only in the basin of the lake Fehér-tó but in the adjacent pastures, plough-lands and even within the buildings, as well. On these we have several data from Kakasszék, Kardoskút—Puszta-Centre and from the confines of Békéssámson.

Now, we discuss two cases from Kardoskút.

1. Fresh green grass spots in dry alkali grasslands

At the southern side of the lake Fehér-tó at Kardoskút there is an old grass composed by the stands of *Festuca pseudovina* HACK. ap. WIESB. In this, for about 20 years, I have kept under observation two grass spots that, even in the time of summer drought, rise above the grass-stand turning yellow, with their fresh green colour. In both grass-spots of moist soil, *Aster tripolium* L. ssp. *pannonicus* (JACQ.) Soó occur in large numbers, and *Trifolium fragiferum* L. and *Trifolium angulatum* W. et K. as well, are frequent, too. On 19 July, 1962, in the larger fresh green spot, we dug a deep pit and, about 4 m from that, in the grass of dry soil, becoming yellow, we dug another the depth of which was about 0.7 m. The wall of the pit made in the fresh green spot began to be wet downwards from a depth of 20 to 25 cm and, about in an hour, it became almost "perspiring" as a result of the appearance of the well-visible water-drops. These, running downwards, made the bottom of the pit muddy. On the wall of the pit, dug in the dry grass, we did not observe any moisture after hours, either. The investigation with the method of pit-pairs was later on repeated on two occasions, with approximately similar results. Between the gaps of the fresh grass spots alga-induced colorations could also be observed. Their constituants are as follows:

1. *Gloeocapsa chroococcoides* NOVACEK
2. *Oscillatoria brevis* (KÜTZ.) GOMONT
3. *Lyngbya Martensiana* MENEGH.

We have often observed fresh green spots of moisty-wet soil, like these, on the confines of Békéssámson, as well. These were, hiddenly, also of "springlet" character.

2. Water uprush appearing in the living-room (Fig. 5)

It is an old experience that in "humid" years the lower part of buildings with adobe walls decays, "corrodes", becomes softened by the water coming from below. This may induce the sinking of the wall. In the living-room of Czuczi's farmstead at the south-western side of the lake Fehér-tó at Kardoskút, on 9 May, 1962, the farmer called our attention to a spot of water uprush in a corner of the room. This made so soft the tamped loan "flooring" that there the chair-leg sank. The wet spot existed for years and in October, 1965, the lower part of the wall sufferred damage as shown in Figure 5, and the wall was in danger of tumbling down. In May, 1968, this farm-house became crooked, its windows and doors were removed. In the corner of the living-room with water uprush we found a bluish-green algal mass-production on 19 May, 1968. This was induced by the following species:

1. *Oscillatoria brevis* KÜTZING
2. *Oscillatoria amphibia* AGARDH
3. *Schizothrix lardacea* (CES.) GOMONT

The building soon tumbled to pieces together with other buildings and the owner made a new building near tho old one on such a place that he new to be free from water uprushes. In this time, in the vicinity of the lake Fehér-tó at Kardoskút—Puszta-Centre a few other farm-steads collapsed, as well, mainly owing to the damaging effect of water uprushes. Such damages of water uprushes from the region of the rivers Maros and Sebes-Körös are known and they are first of all connected

Fig. 5. The wall of the farm-house is ruined by a water-uprush. In one of the corners of its room, the floor is also sodden by the water-uprush to be swampy. Here later an algal mass-production was formed.

with flood prevention. From the environs of Makó, the following were written by MÁRTON sixty years earlier: "On the occasion of floods, large devastations are induced by the up-welling water. The cellars are filled with water, the plough-lands in the neighbourhood of levees are covered with up-welling water. Into the earthen floor of the houses, built in the rather flat part of villages and belonging, as a rule, to poor people, which are bulking of welling-up water, the chair-leg generally sinks in if somebody sits down on them." (MÁRTON, 1914). The matter in question is here that the welling-up waters occur at the flood of the river Maros. Close to the river Sebes-Kőrös, at Kőrösladány, in the days of the large flood in 1970, in the kitchen of the house MÁRTON NAGY street No 3, near the levee, a water uprush appeared, known at present in flood defence works as "buzgár" (bubbling-up flood). Half part of this short small street was to be demolished because the houses became dangerous to life. Today a vegetable garden is in the place of houses.

Main form IV: Marsh uprushes

Their essence is that the rushing-up water cannot directly reach the surface but it softens certain layers of the subsoil so much that these are transformed into a marshy mass and pressing upwards the moistening surface, they induce there a bulge. We have observed a number of cases but now we can only demonstrate one of these.

1. A bulging marsh uprush at Kardoskút—Puszta-Centre in 1970 (Fig. 6)

In the days of the Great Flood Defence Work in the Lower Tisza Region, in Spring 1970, dramatic events took place at Kardoskút—Puszta-Centre, as well. At the lake Fehér-tó, bulging marsh uprushes were observed in two places. One of these was directly south of Czuczi's farmstead, the other at the eastern end of the lake. The former soon "welled up" and "ebbed". That at the eastern end of the lake, however, only shrank and became lower but, in this case, too, its relative height reached 30 cm. In Spring, the bulging still sagged under the body weight, in Autumn, however, it only trembled under footsteps and a crevice of north-south direction began to form in it. This is shown by Figure 6 from 6 November, 1970. The surface of the hump is bare along the crevice, its pH-value is 9.2. On the sloping part of the hump *Puccinellia distans* (L.) PARL. became acclimatized in bunches. The inner, still mostly wet, surface was here and there covered by green or blue-green algal coating. In forming this, the following species have taken part:

1. *Myxosarcina spec.*
2. *Oscillatoria brevis* KÜTZING
3. *Oscillatoria angustissima* W. et G. S. WEST
4. *Lyngbya Martensiana* MENEGH.
5. *Chlorococcum infusionum* (SCHRANK) MENEGH.
6. *Planophila laetevirens* GERNECK.

I continued examining this forming of a hump in 1971, and it could be ascertained that below the about 30 cm thick hard soil layer of the bulge such a marsh-like soaked "soil-lens" takes place that is strongly convex on its lower side but on the upper side it is only flatly bulging (KISS, 1972). The largest thickness of this

marsh-like soil-lens, about at its middle part, somewhat surpassed 2 m. The substance can be considered mostly as gley and immediately under the crevice it is of pseudo-gley character. At the lower part of the ample crevice, as well as on the desiccated surface of the soil-lens below the crevice, an algal mass-production manifested itself. I have examined the composers of this on 16 August and 31 November. My results are the following:

16 August:

1. *Synechococcus elongatus* NAEG.
2. *Gloeocapsa salina* HANSGIRG
3. *Myxosarcina spec.*
4. *Anabaena variabilis* KÜTZ. f. *tenuis* POPOVA
5. *Oscillatoria brevis* (KÜTZ.) GOMONT
6. *Phormidium ambiguum* GOMONT
7. *Lyngbya Martensiana* MENEGH.
8. *Schizothrix lacustris* A. BRAUN
9. *Tolypothrix spec.*
10. *Anomoeoneis sphaerophora* (KÜTZ.) PFITZ.
11. *Navicula gregaria* DONK.
12. *Chlorococcum infusionum* (SCHRANK) MENEGH.

31 October:

1. *Myxosarcina spec.*
2. *Anabaena variabilis* KÜTZ. f. *tenuis* POPOVA
3. *Oscillatoria brevis* (KÜTZ.) GOMONT
4. *Phormidium ambiguum* GOMONT
5. *Lyngbya Martensiana* MENEGH.
6. *Tolypothrix spec.*
7. *Anomoeoneis sphaerophora* (KÜTZ.) PFITZ.
8. *Chlorococcum infusionum* (SCHRANK) MENEGH.
9. *Planophila asymmetrica* (GERNECK) WILLE
10. *Gongrosira trentepohliopsis* var. *natrophila* KISS. I.

The role of water uprushes in the "variegation" of the alkali soils

On the basis of my experiences of several decades I see so that the processes of water uprushes are one of the decisive factors, pivotal questions, of the mosaically heterogeneous character, "variegation" of alkali soils. This follows, at any rate, already from the generally accepted opinion, too, that the alkali soils are hydrogenetic soils. That is to say, in the course of their formation and further changes, the motion of the subsoil water and surface water is of decisive effect.

On the surfaces of water uprushes also tiny, 1–2 mm holes can be observed, mostly in dry state. If we walk on the spot which is still in muddy state, from the small holes water uprush, bursting-out may be observed. I have often experienced, too, that the immediate environs of the small holes represent a one or two mm "higher" terrain and that here the surface is richer in grains of sand than the farther places of the uprush. Otherwise, it can be seen even in the presented pictures that

the spots of water uprushes stand out a little from the bottom of the lake, almost as small "cushions". The spouting water can namely bring matters from below the surface which get gradually separated from the water spreading in all directions on the surface. First the drifted grains of sand settle down, then the clayey, colloidal matters get separated, the dissolved salts getting the farthest. The separation of these takes place according to their solubility.

Some qualitative differences may manifest themselves even within the already formed spots of water uprushes. On the major spot which is already dried or drying up, minor sub-spots appear, corresponding to the pressure fluctuations of the repeated water uprushes, resp. of the subsoil water. The differences of minor spots are also indicated by the algal mass-productions. These coloured "soil efflorescences" ("flos humi") represent changing populations, sometimes within even cm distances. The appearance of algal mass-productions refers to the effect of certain stimulatory substances. These, too, get to the surface of the soil together with the rushing up water. The spotty indicators of the subsoil water are the spots of macrovegetation, as well. The vegetative spots of *Bolboschoenus maritimus* are called "mudstained" even today by old agriculturer labourers because here the boots can become wet or muddy even in a dry weather.

In the course of the present-day flood-prevention, the water rushing up in the area protected by the levees has been denominated in Hungarian "buzgár" (spouting flood). The discussed phenomena of water uprush are similar because the basin of the lake Fehér-tó at Kardoskút—Puszta-Centre had in times past been the bed of a primaeval river.

Fig. 6. Marshy water-uprush of bulging surface at the eastern end of the lake Fehér-tó. It was formed in Spring 1970, in the period of the Great Flood-Prevention in the Lower Tisza Region. The surface of crevasses is stained by algal mass-production.

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DATA ON THE PERIPHYTON OF THE BALATON

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Abstract

The author has processed the periphyton samples of reeds, bulrushes and of the hair-weed vegetation at five different points of the northern side of Lake Balaton. In one of the sample series the periphyton associations of the Paloznak-bay in the vicinity of Balatonfüred are discussed in this paper. It ascertains that there are differences in the composition of the periphyton both according to the undergrowth and to the levels of depth. The periphyton associations within the reeds and at their fringe towards the water differ from one another in the same way. He found particularly in the periphyton associations in the interior of reed banks numerous algae that are otherwise characteristic of the transitory bogs. The separation of types will only be possible after elaborating further partial results in the relation of the periphyton of the Balaton.

Introduction

From among the algal organizations of the Balaton those to be found in the "plankton" have been studied the most exhaustively. About the algae of the "benthos" we have less knowledge. (For explaining the quotation-marks = the Balaton is a shallow lake, its water is stirred till the bottom by strong enough waves. The organisms floating in it and those living fallen down to the surface of the sediment may esasily change their place. There are, therefore, in the plankton some organisms stirred up from the bottom and this is true just the other way round, as well.)

The least investigated and known biotope of the water of the Balaton is the sometimes considerable macrophyton zone of the inshore fringe (reeds, walrushes, etc.), the coating, living on the stems of plants, thus also the periphyton formed by the algae. This, however, belongs, according to a preliminary estimate, in respect of its biomass, its active total surface, to the same order of magnitude as the phytoplankton and phytobenthos of the lake.

It is beyond question that the periphyton of the macrophyton-zone of the lakeshore exerts its effect on the life of the lake in another way than the phytobenthos on the surface of the sediment. While the latter ones are in an intensive connection quasi with the whole of the lake water, the fixed algal associations living in the inshore macrophyton-zone — mainly in the internal part of the zone — exert their effect rather in the zone, including also their influence exerted on the waters flowing into the zone. Thus the periphyton there supposedly strongly contributes to the "filtering function" of the macrophyton-zone from both the direction of the open water and that of the shore. The degree of this contribution and generally the extent

of the "filtering function" of the macrophyton-zone are not revealed exactly, as yet, but they are rendered considerably probable with practical observations. We know, at any rate, since the investigations of FELFÖLDY and TÓTH (FELFÖLDY—TÓTH, 1957; TÓTH 1960a; 1960b), that in the macrophyton-zone peculiar water-chemical — and consequently peculiar plant-coenological — conditions can be formed. These peculiarities have been emphasized in the algological investigations until now, as well.

The periphyton of the Balaton was first investigated by CHOLNOKY (1929) and MESCHKÁT (1934) and, later on, such studies were made by TAMÁS (1958, 1964). It is to be seen from this enumeration, as well, that the researchers still have very much to do here, particularly if we think of that investigations like these took only place at few points of the Balaton, as yet. We are still far away from that, in possession of a richer series of data, we can recognize and separate of une another the different types of the periphyton in the Balaton.

Materials and Methods

In order to contribute to the knowledge of the periphyton in the Balaton, in 1976 and 1977 I studied it at several points of the northern shore of the Balaton.

I have taken my periphyton samples from the following points: from the reeds of the Paloznak-bay NE of Balatonfüred, from the reeds of the stretch named Sajkód of the western shore in the peninsula Tihany, from the reeds and bulrushes of the Bozsa-bay west from the neck of the peninsula Tihany, from the reeds of the shore-stretch before Zánka in the southern basin of the Balaton, and from one of the reeds of the bay at Keszthely.

In the composition, stand-density of the periphyton associations, there occur generally no quick changes, apart from the mechanical damages induced by very strong waves and the ice-covering. Thus the processing of the samples, taken in early summer and later, in late autumn-early winter — but anyhow before freezing of the Balaton — offers a good survey of the composition of the periphyton. On the other hand, it is necessary to uncover at both dates the different periphyton biotopes as detailed as possible. We take therefore samples from the reeds living at the water-side fringe of the reeds and from those inside of the reedy part, in particular from different levels of the single reeds, excised from as deep as possible (e.g., 0 cm, 20 cm, 40 cm, 80 cm, 100 cm, 150 cm) and from the periphytons being on the surface of other plants living among the reeds or in the "clearings" of reeds in rather high individual numbers, for instance from *Stratiotes aloides, Myriophyllum, Utricularia, Potamogeton pectinatus*. We take samples from older floating reeds, too. In bulrushes, as well, we can think of a similarly differenciated sampling, like in reeds.

The stem-parts detached from the different levels of reeds — after being fixed in a Lugol solution of sodium acetate and preserved with formalin of 1,5—2 percent end-concentration — are stored separately until being processed. Processing takes place on a matter scratched off from the stem-parts with a scalpel. The matter of examination, obtained from the surface of a unit (1 sq.cm), is suitable for getting absolute quantitative data (ind./sq. cm) while from the investigation of some matter, obtained not from a unit surface, relative quantitative data (frequency of the single taxons, expressed in the percentage of the occurrence of all the taxons) can be obtained, resp., in a simpler case, the dominance relations can be estimated.

In my investigations I was supported by more than one research worker of the Biological Research Institute of the Hungarian Academy of Sciences, by taking me with motorboat to the place of sampling and helping me in the difficult enough sampling, as well. The processing of samples was mostly carried out in the Institute in Tihany, included making microphotographs, as well. Special thanks are due for the help and for ensuring me the possibility of my research work.

On the periphyton of the reeds in the Paloznak-bay

Before publishing the detailed taxonomical-coenological data of my investigations, obtained until now into the periphytons of the Balaton, I am presenting in the following my major results concerning one of my areas investigated in detail, the bay at Paloznak.

The bay at Paloznak is a bay of the Balaton, S of the village Paloznak, with a 1.1 km wide opening, a 650 m slight incurvation, covered with uniform, dense, strongly growing reeds. One can enter the reeds in a boat, through a few narrow cuttings. In these cuttings, *Utricularia, Stratiotes* make here and there large stands and, at the fringe of these cuttings, also smaller *Typha*-stands variegate the reeds sporadically.

I want to present the varied, rich composition of the periphyton here, through characterizing the samples taken on 24 June, 1976.

1. The periphyton samples of the young reeds living in the fringe of reeds towards the water:

(a) In 10 cm water depth. — Quantitatively dominant (in individual number) (D): the pedunculated *Rhoicosphenia curvata* (KÜTZ.) GRUN. and *Gomphonema olivaceum* (LYNGB.) KÜTZ. var. *calcareum* CLEVE, as well as, among them, *Epithemia sorex* KÜTZ. — There are present subdominantly (SD), i.e., in lower but still obvious individual number: *Cymbella laceolata* (EHRBG.) van HEURCK, with large, pedunculated individuals (on this peduncle several *Achnanthes* sit, like *A. microcephala* KÜTZ., *A. minutissima* KÜTZ., *A. linearis* W. SMITH), as well as other *Cymbella*-species, like the individuals of *C. cistula* (HEMP.) GRUN. sitting on peduncle stems, and those of *C. prostrata* (BERK.) CLEVE, taking place in a peduncle sac. From among the 34 further algal taxons, found in this periphyton association, there are some fixed filaceous organisms (e.g. *Coleochaete divergens* PRINGSH., *Tolypothrix tenuis* KÜTZ.), some fixed unicellular organisms (e.g. *Gomphonema intricatum* KÜTZ.), some organisms "caught" by the periphyton (e.g. *Coelosphaerium naegelianum* UNG., *Lyngbya limnetica* LEMM., *Planctonema lauterbornii* SCHMIDLE, *Cosmarium meneghinii* BRÉB., *Cosmarium obtusatum* SCHMIDLE, *Staurastrum tetracerum* RALFS., *Epithemia zebra* (EHRBG.) KÜTZ., *Synedra acus* KÜTZ.).

(b) On the same reed, in 100 cm water depth. — D: *Cymbella lanceolata, Epithemia sorex, Rhoicosphenia curvata,* SD: *Gomphonema olicaceum* var. *calcareum, Epithemia zebra.* As compared with the former sample, there is only a minor redistribution of importance in the dominance relations. Apart from the above mentioned ones, further 30 algal taxons take part in forming the periphyton, among them a few diatoms of rather large size: *Gyrosigma attenuatum* (KÜTZ.) RABENH. *Synedra ulna* (NITZSCH) EHRBG. var. *biceps* (KÜTZ.) SCHÖNF., some Chlorococcales *Pediastrum boraynum* (TURP.) MENEGH., *Scenedesmus quadricauda* (RP.) BRÉB. var. *quadrispina* (CHOD.) G. M. SMITH and Desmidiales: (*Closterium parvulum* NAEG. and *C. setaceum* EHRBG.). From among the green algae, following a fixed course in life, the occurrence of *Aphanochaete pascheri* HEERING is interesting here.

2. The periphyton living on the single levels of reeds, taken from the inside of the reedy shore:

(a) Water-line (0 cm). — The "beard" made by *Spirogyra* sp. (*Spirogyra schmidti*? W. et G. S. WEST?), *Oedogonium* sp. and *Tolypothrix tenuis* KÜTZ. and therein *Epithemia sorex* dominate quantitatively. SD: *Rhopalodia gibba* (EHRBG.) O. MÜLL., *Epithemia zebra, Radiofilum flavescens* G. S. WEST. From among the further 45 algal taxons, observed in the sample, 11 are Cyanophytic organisms and 21 Chlorophytic organisms, the others are — with the exception of one Chrysophyceae taxon — all Bacillariophyceae. Some interesting occurrences are: *Scenedesmus balatonicus* HORTOB., *Coleochaete scutata* BRÉB., *Geminella interrupta* TURP.,

Gonatozygon brebissonii DE BARY, *Gloeobotrys limneticus* (G. M. SMITH) PASCHER, as well as a form of giant-cell of *Rhopalodia gibba*.

(b) 20 cm water depth. — Here a "beard" made by a *Cladophora* (*C. vadorum* (ARESCHOUG) KÜTZ.?) dominates quantitatively. SD:*Cocconeis placentula* EHRBG., *Epithemia sorex, Navicula radiosa* KÜTZ. From among the further 64 algal taxons, determined from the sample, there are not more than 6 Cyanophyta; on the other hand, the number of the Chlorophytic organisms is 32; the others — with the exception of 1 Pyrrophyta and 2 Xanthophyceae — are all Bacillariophyceae taxons. Fairly interesting occurrences are: *Palmellocystis planctonica* KORS., *Radiococcus nimbatus* SCHMIDLE, *Scenedesmus acutiformis* SCHRÖD., *S. balatonicus* HORTOB., *Cosmarium perforatum* LUND., *C. tinctum* RALFS., *Staurastrum alternans* BRÉB., *Ophiocytium cochleare* A. BR.

(c) 40 cm water depth. — The "beard" is formed hear, apart from the *Cladophora*, by an *Oedogonium* sp. But here these filaceous organisms are more covered with diatoms than on the level over it. The subdominant organism are found among these diatoms: *Epithemia sorex, Gomphonema acuminatum* AHR. forma, *Rhopalodia gibba*. Here and there the peculiar, 8–10 mm long thalluses of *Chaetophora incrassata* (HUDSON) HAZEN, of similarly subdominant occurrence, can be seen. On these lower individual numbers of *Tolypothrix tenuis, Epithemia zebra,* and *Rhopalodia gibba* settled. In addition to the afore-mentioned ones, I have determined from the sample further 31 algal taxons. From among these there are 5 Cyanophytic and 8 Chlorophytic organisms while the others — with the exception of one Euglenophytic and one Xanthophyceae organism — are Bacillariophyceae. Fairly interesting occurrences are: *Entosiphon polyaulax* Skuja forma (only half as large as described by Skuja), *Gongrosira prostrata* JAO, *Gonatozygon kinahanii* (ARCH.) RABENH., *Staurastrum teliferum* RALFS forma (with longer spines than at the type).

(d) 80 cm water depth. — In the composition of the filaceous coating, *Gogrosira prostrata* is dominant. Besides it, an *Oedogonium* sp. and, sitting on it, *Epithemia turgida* (EHRBG.) are also dominant quantitatively. *Eunotia lunaris* (EHRBG.) GRUN. var. *capitata* GRUN. and *Epithemia argus* KÜTZ. mean a peculiar subdominant occurrence. Apart from the listed ones, not more than 23 further algol taxons could be observed in the sample. There were among these one Cyanophytic and 6 Chlorophytic organisms, the others were — with the exception of one Xanthophyceae taxon — all Bacillariophyceae. Rather interesting occurrences are: *Microcystis aeruginosa* KÜTZ. f. *sphaerodictyoides* ELENKIN, *Tolypohtrix tenuis, Tribonema affine* G. S. WEST, *Eunotia lunaris* var. *subarcuata* (NAEG.) GRUN.

3. A sample taken from 0–15 cm water depth, from a *Typha* stem, at the fringe of a cutting with *Utricularia* within the reedy part. — The main mass of the coating is formed by a blue-green alga of filaceous structure: *Microchaete* sp. (*M. brunnescens* KOMÁREK?). Subdominantly *Amphipleura pellucida* KÜTZ. and *Navicula radiosa* are present. Apart from the mentioned ones, further 37 algal taxons could be determined from the sample. Rather interesting occurrences are: *Lyngbya aestuarii* (MERT.) LIEBMANN, *Aphanochaete repens* A. BR., *Bulbochaete* sp. (*B. elatier* PRINGSH.?), *Coleochaete divergens* PRINGSH., *Ophyocytium longipes* PASCHER. *O. maius* NAEG.

4. Algal coating on the leaves of the Stratiotes specimens of the cutting with *Utricularia* (Lichtung im Röhricht mit *Utricularia*-Bestand). D: *Epithemia turgida, Rhopalodia gibba,* SD: *Epithemia zebra* var. *porcellus* (KÜTZ.) GRUN., *Navicula*

radiosa. Apart from the above mentioned ones, I have determined 49 algal taxons from the sample. Among these, there were comparatively many, together 12 Desmidiales taxons. Rather interesting occurrences are: *Coleochaete pulvinata* A. BR., *C. scutata* BRÉB., *Quadriococcus ellipticus* HORTOB. forma (on the cell pole there is no cell-wall thickening), *Cosmarium bioculatum* BRÉB. f. *depressa* SCHAARSCHM., *Gonatozygon ehrenbergii* (BRÉB.) DE BARY.

5. Squeezing of *Utricularia* grass from the cutting with *Utricularia*. — Squeezing the extremely dense *Utricularia* grass, we have got a sample, strikingly rich in, taxons. Among the algae fixed here, there are some living fixed on the *Utricularia* itself, as well as some planktonic elements, caught by the dense, filter-like behaving grass, and there visibly further multiplying. D: *Navicula radiosa,* SD: *Amphipleura pellucida, Fragilaria construens* (EHRBG.) GRUN. Apart from these, 116 algal taxons could be determined from the sample. The taxonomical spectrum of the sample differs in numerous relations from the other periphyton samples, taken from the bay at Polaznak in this period. Cyanophyta: 16 taxons, Chlorococcales: 30 taxons, Desmidiales: 19 taxons, Chrysophyceae-Xanthophyceae: 4 taxons, Bacillariophyceae: 38 taxons. In the taxonomical composition, the comparatively large number of Chlorococcales and Desmidiales taxons is striking. Rather interesting occurrences are: *Entosiphon sulcatum* (DUJ.) STEIN, *Euglena pisciformis* KLEBS, *E. polytrophos* POCHM., *E. variabilis* KLEBS., *Phacus contortus* BOURR., *Gloeoactinium limneticum* G. M. SMITH, *Scenedesmus acutiformis* (8-celled coenobia, as well!), *Sorastrum spinulosum* NAEG., *Closterium ehrenbergii* MENEGH., *Cosmarium regnellii* WILLE, *C. undulatum* CORDA var. *crenulatum* (NAEG.) WITTR., *Sphaerozosma muticum* BRÉB., *Staurastrum polymorphum* BRÉB. forma (with a shallow hollow on the cell pole), *Geniochloris laevis* PASCHER, *Eunotia tenella* (GRUN.) HUST., *Pinnularia stauroptera* (RABENH.) CLEVE forma (it is significantly larger than the type).

The periphyton of the investigated individual reeds differred according to levels. There are differences in the dominance conditions, in the number of the algal taxons forming the periphyton and partly in its common taxonomical composition, too.

The periphyton associations of the water-side fringe of reeds and of the inside of reeds also differ from each other. The former ones are poorer, as a result of employing the water motion mechanically, both in respect of the number of taxons, and from the point of view of the population. Their depth levels, however, resemble each other much more. The latter ones are taxonomically richer, and contain several such organism (Desmidiales-taxons, *Eunotia* spp., etc.) which are characteristic of the transitory bogs.

The periphyton of bulrush stems differs from that of reeds in more than one essential trait. Similarly, the periphyton of the *Stratiotes* specimens, found in the cutting, fringe of reeds, differs from the periphyton of reeds.

The periphyton of the *Utricularia* grasses, living in the cuttings of reeds and being remarkably rich in species, contains — besides the typical fixed organisms — particularly numerous and in the given association further multiplying elements, although such elements can be found in every periphyton in a certain quantity.

The here discussed and other results of my investigations unambiguously refer to that, in the present-day water-chemical situation, the developing periphyton is considerably determined by its "undergrowth". The compared results of several such investigations will conduct to the recognition of types.

The periphyton associations developing on the macrophyton vegetation of the

Balaton contain a number of such algal taxons that can hardly or not at all found in our other water biotopes.

Even a simple microscopical examination of the periphyton-associations of the Balaton convinces us that the matter in question in the biomass, on the active surface, very considerable water associations are concerned, the role of which, played in the life on the Balaton, deserves to be revealed by the research as detailed as possible.

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SCANNING ELECTRON-MICROSCOPICAL INVESTIGATIONS INTO THE SPOROMORPHES OF THE COAL LAYERS IN THE DOROG BASIN

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Abstract

In this paper, the results of the scanning electron-microscopic investigations of the sporomorphous types — that are particularly characteristic of the layers of the lower coalification cycle of the brown-coal bed in Dorog — are summarized. On the surface of the investigated spores (*Leiotriletes adriennis, L. dorogensis, Cicatricosisporites dorogensis* subfsp. *dorogensis, C. dorogensis* subfsp. *dorogensis* fvar. *rugulatearis, Polypodiaceoisporites speciosus, Microfoveolatosporis pseudos dentatus*), with the exception of Microfoveolatosporis pseudodentatus, some characteristics could be demonstrated which could not be recognized with light microscopes. In case of Leiotriletes fgen., these formations seem to be of taxonomical value. *Psosphosphaera intrapuctata*, on the basis of its submicroscopical formations on the surface, is not similar to recent Gymnospermatophyta pollen grains. The matter in question is, probably, a died out taxon. It is very well separated by its surface formations from other fossil and recent inaperturate forms. From among the pollen grains which are very characteristic of coal layers, on the surface of *Monocolpopollenites tranquillus*, there is a well definable verrucate-rugulate sculpture. On the basis of the results of the investigations into several specimens, these formations are of changing size.

Introduction

Concerning the light-microscopic palynological investigation into the lower coalification cycle of the coal-basin at Dorog, several literary data are available for us (e.g.; POTONIÉ & GELLETICH, 1933; KEDVES, 1960, 1961, 1962, 1969; RÁKOSI, 1973). The total of brown coal is, on the basis of these, rich in sporomorphes. The number of the separated form-species is, however, comparatively low. Among the Angiospermae the palms have a special importance in the vegetation forming these layers.

The intensive scanning electron-microscopical palynological investigations, starting in the second half of the past decade, yielded several new results at the fossil sporomorphes, as well. These investigations, particularly in case of pollen grains, apart from improving on the earlier statements concerning the surface formations, have thrown a new light, in a number of cases, upon the taxonomical phylogenetical connections, too. It is interesting that the application to the Palaeo- and Mesozoic sediments has become much more general than to the sporomohes of the younger, Tertiary layers. STANLEY and KEDVES (1975) also referred to this problem of the fossil pollen grains of Angiospermatophyta.

There are known about the scanning electron-microscopical investigation into the fossil sporomorphes in Hungary so far but a few data (STANLEY & KEDVES, 1975; KEDVES & STANLEY, 1976a, b; KEDVES & RADVÁNSZKI, 1975; KEDVES, 1974).

The continuation of these investigations in the interest of the more perfect evaluability of the home sporomorphes coming from the Palaeogene period, well-known by the light-microscopical method, is also supported by the results until now. Several authors referred to the importance of the method, e.g., MARTIN (1969), TAYLOR & MILLAY (1969), JARDINÉ & RAYNAUD (1972), CERCEAU, HIDEUX, LACHKAR, MASURE, RENAULT-MISKOWSKI, ROLAND, TANGOURDEAU-LANTZ & YBERT (1976).

This paper renders account of the result of the first scanning electron-microscopical examination of the important enough sporomorphes in the habitat in Hungary which, at any rate, is counted among the classical ones even in international relation.

Materials and Methods

The material of investigation originates from boring N–33 in the Nagysáp area in the Dorog basin, from the depth-gaps 465.0–465.4 and 466.2–466.8 m of the total brown-coal bed of the lower coalification cycle. The dry matter was carried, by means of a glass-needle, on a glass-plate covered with a polyvinylchloride adhesive and then evaporated with a gold-palladium binary alloy. The investigations were carried out with a JSM 50-A electron microscope, with tilting in an angle of 45 degrees, in the Electron-Microscopical Laboratory, placed in the Department of Zoology of the Lorand Eötvös University. For the kind help I express my special thanks, in this way too, to the Head of the Department, Dr. J. KOVÁCS and to J. BAGI, technician.

Results

Fgen.: *Leiotriletes* (NAUMOVA 1937) R. POT. et KRP. 1954.

1. *Leiotriletes adriennis* (R. POT. et GELL. 1933) W. KR. 1959.

In respect of its light-microscopic taxonomy, the publications of POTONIÉ & GELLETICH (1933), THOMSON & PFLUG (1953), KRUTZSCH (1954, 1959), KEDVES (1961), KEDVES & KEREPECZKY (1966) may be mentioned.

The usual picture of lesser magnifying (×2000: Plate I, 1) did not demonstrate any important new datum about the expressly sculptureless surface, only so much that the spore wall somewhat emerges beside the tetrad-mark. But the picture of ×10000 magnifying (Plate I, 2) resulted in a definitely granular surface. The size of the ornamental elements is generally about 0.1 μ, they take place densely or sometimes in a distance of maximum 0.2 μ. They anastomose but rarely and then a fine rugulate ornametation comes about.

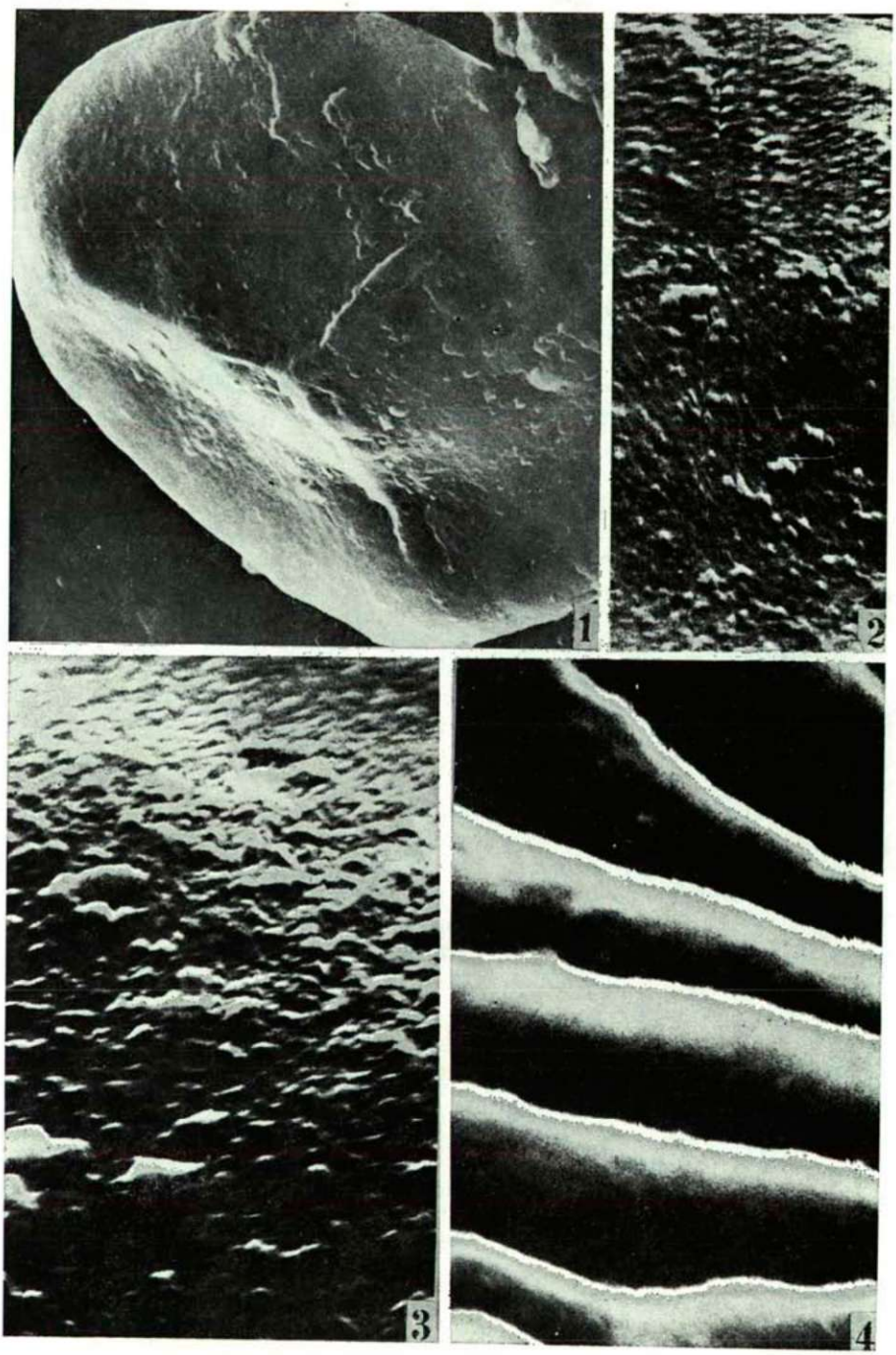
2. *Leiotriletes dorogensis* (KDS. 1960) KDS. 1961.

As the picture of lesser magnifying has brought nothing that is essentially new in respect of the earlier knowledge, we publish here only a picture of ×10000 magnifying (Plate I, 3). The ornamentation of the surface is primarily rugulate, here

Plate I

1. *Leiotriletes adriennis* (R. POT. et GELL. 1933) W. KR. 1959, Schizaeaceae, cf. *Lygodium*; a comprehensive view over the surface of the spore, x2000.
2. *Leiotriletes adriennis* (R. POT et GELL. 1933) W. KR 1959, Schizaeaceae, cf. *Lygodium*; a detail of the submicroscopical sculpture of the surface, x10 000.
3. *Leiotriletes dorogensis* (KDS. 1960) KDS. 1961, Schizaeaceae, cf. *Lygodium*; a detail of the submicroscopical sculpture of the surface, x10 000.
4. *Cicatricosisporites dorogensis* R. POT. et GELL. 1933 subfsp. *dorogensis*, Schizaeaceae, *Anemia*; a part of the sculpture of the distal side, x10 000.

Plate I



and there verrucate. The verrucae are of 0.5–0.3 μ diameter, the width of the rugulate ornamentation is generally 0.2 μ, its length is changing, about 0.3–0.7 μ.

Fgen.: *Cicatricosisporites* R. POT. et GELL. 1933.

1. *Cicatricosisporites dorogensis* R. POT. et GELL. 1933 subfsp. *dorogensis*.

A scanning electron-microscopical picture about the spore was made by SRIVASTAVA (1972) at first. The pictures of ×1000 magnifying brought nothing that is new, as compared with with the results of light microscopes. In our picture of ×10000 magnifying (Plate I, 4) we have succeeded to recognize flat granule-like but not expressed formations on the surface of muri, on a surface that light-microscopically seemed to be smooth.

2. *Cicatricosisporites dorogensis* R. POT. et GELL. 1933 subfsp. *dorogensis* fvar. *rugulatearis* KDS. 1961.

The transition of the canaliculate sculpture into a sporadically rugulate ornamentation is very obvious in the picture of ×2000 magnifying (Plate II, 1). It is interesting that even at a magnification like this, the tiny granule-like formations, located sparsely on the large sculpture elements, can be observed well.

Fgen.: *Polypodiaceoisporites* R. POT. 1956.

1. *Polypodiaceoisporites speciosus* (R. POT. 1934) R. POT. 1956.

On the proximal side, a further fine ornamentation of the sculpture elements can be observed; a similare and more express one on the rugulate elements of the distal sculpture (Plate II, 2, 4). This is a fine granulate-rugulate ornamentation. The surface of the zone is not smooth, either, but finely granular, the size of granules being maximum 0.1 μ (Plate II, 3).

Fgen.: *Microfoveolatosporis* W. KR. 1959.

1. *Microfoveolatosporis pseudodentatus* W. KR. 1959.

The scanning electron-microscopical results only support the light-microscopical observations although on the muri a further granular structure is visible; this, however, is not convincing, according to the foregoing (Plate II, 5, 6).

Fgen.: *Psophosphaera* NAUMOVA 1937 ex BOLCHOVITINA 1953.

1. *Psophosphaera intrapunctata* (KDS. 1961) n.comb.

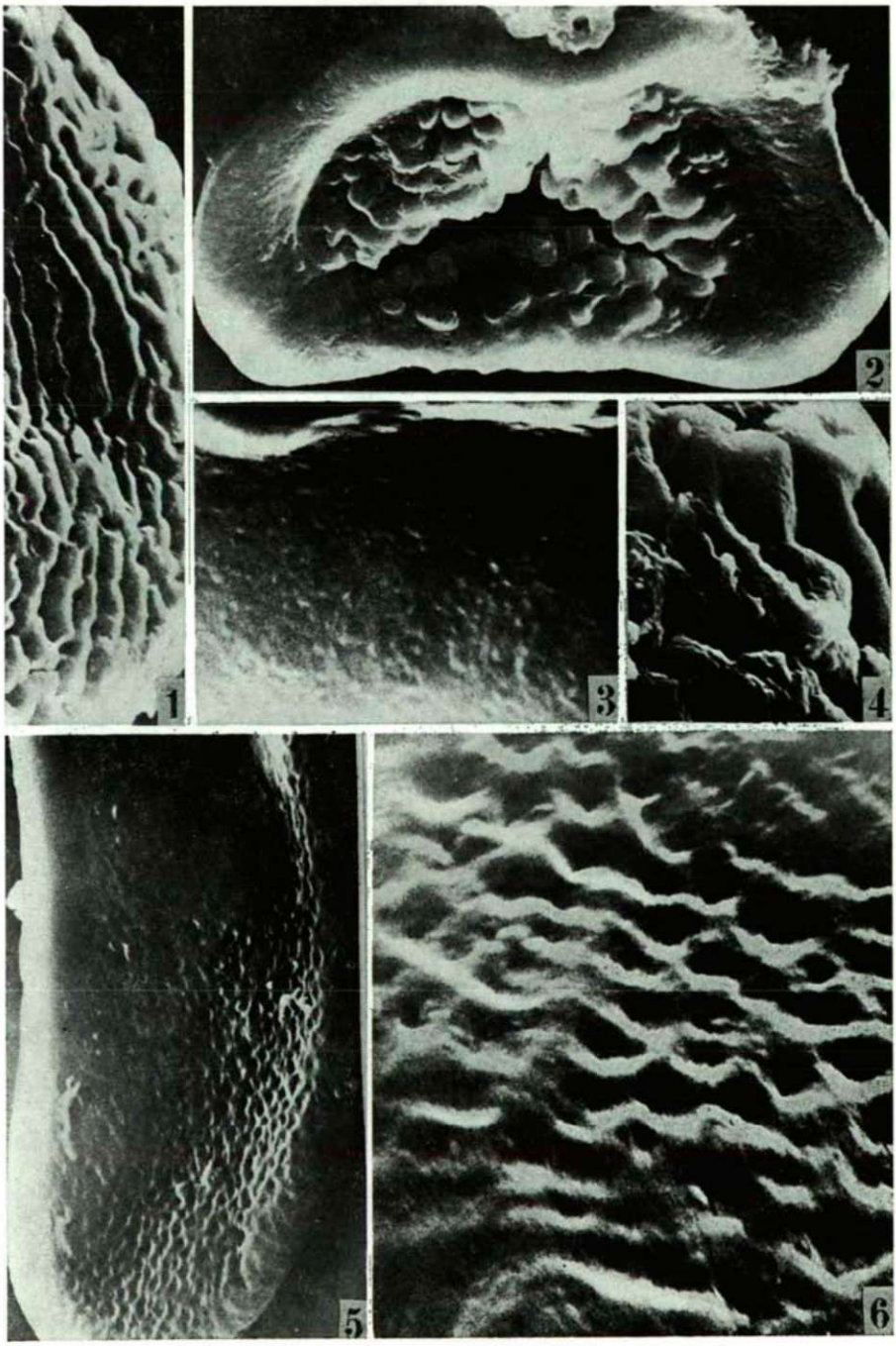
Syn.: KEDVES 1961 — *Laevigatasporites intrapunctatus* n.fsp.

They are extremely problematical forms. At this form species we have, therefore, examined several specimens which led to an identical result. The submicroscopical ornamentation of the surface bearing light-microscopically no definite sculpture is double. On the one hand, the surface is uniformly covered by very small granules

Plate II

1. *Cicatricosisporites dorogensis* R. POT. et GELL. 1933 subfsp. *dorogensis* fvar. *rugulatearis* KDS. 1961, Schizaeaceae, *Anemia*; a detail of the ornamentation of the spore, x2000.
2. *Polypodiaceoisporites speciosus* (R. POT. 1934) R. POT. 1956, Pteridaceae; a comprehensive view over the proximal surface of the spore, x2000.
3. *Polypodiaceoisporites speciosus* (R. POT. 1934) R. POT. 1956, Pteridaceae; a detail of the submicroscopical ornamentation of the proximal side of the cingulum, x10 000.
4. *Polypodiaceoisporites speciosus* (R. POT. 1934) R. POT. 1956, Pteridaceae; a detail of the sculpture of the distal side, x2000.
5. *Microfoveolatosporis pseudodentatus* W. KR. 1959, Psilotaceae; a detail of the surface ornamentation of the spore, x2000.
6. *Microfoveolatosporis pseudodentatus* W. KR. 1959, Psilotaceae; a detail of the sculpture of the surface, x10 000.

Plate II



below 0.1 μ which sometimes look like coni (Plate III, 2). Apart from this, there is a characteristically stried ornamentation, as well. This is irregular, ramifying, in the middle of the striation there are often some hollows, as well, and only its both edges emerge (Plate III, 1, 2). This surface ornamentalness may raise the idea that above the solider muri there is also a formation, similar to a thin perisporium.

Fgen.: *Monocolpopollenites* TH. et PF. 1953.

1. *Monocolpopollenites tranquillus* (R. POT. 1934) TH. et PF. 1953 subfsp. *tranquillus*.

From the point of view of the knowledge of the vegetation, having formed the brown coal-bed layers from the lower Tertiary, this pollen is particularly considerable, first of all at the brown-coal bed layers of Dorog type.

The express sculpture is very obvious in but less magnified scanning pictures, as well (Plate III, 3, 5). Six specimens got under scanning electron-microscopical investigation. These led qualitatively to an identical result but as to the sizes of ornamentation, variation is large enough. The sculpture is rugulate-verrucate. The size of the rugulate ornamental elements is highly changing: 0.5–1.2 μ (Plate III, 4, 6).

Fgen.: *Arecipites* WODEHOUSE 1933.

1. *Arecipites granulatus* (KDS. 1961) L. RÁKOSI 1973.

The fine reticulate ornamentation can be observed very well with the scanning electron-microscopical method (Plate III, 7, 8). It is essentially new that the surface is identical in the germinal and extragerminal regions, too. This could not be demonstrated, so far, with the light-microscopical method.

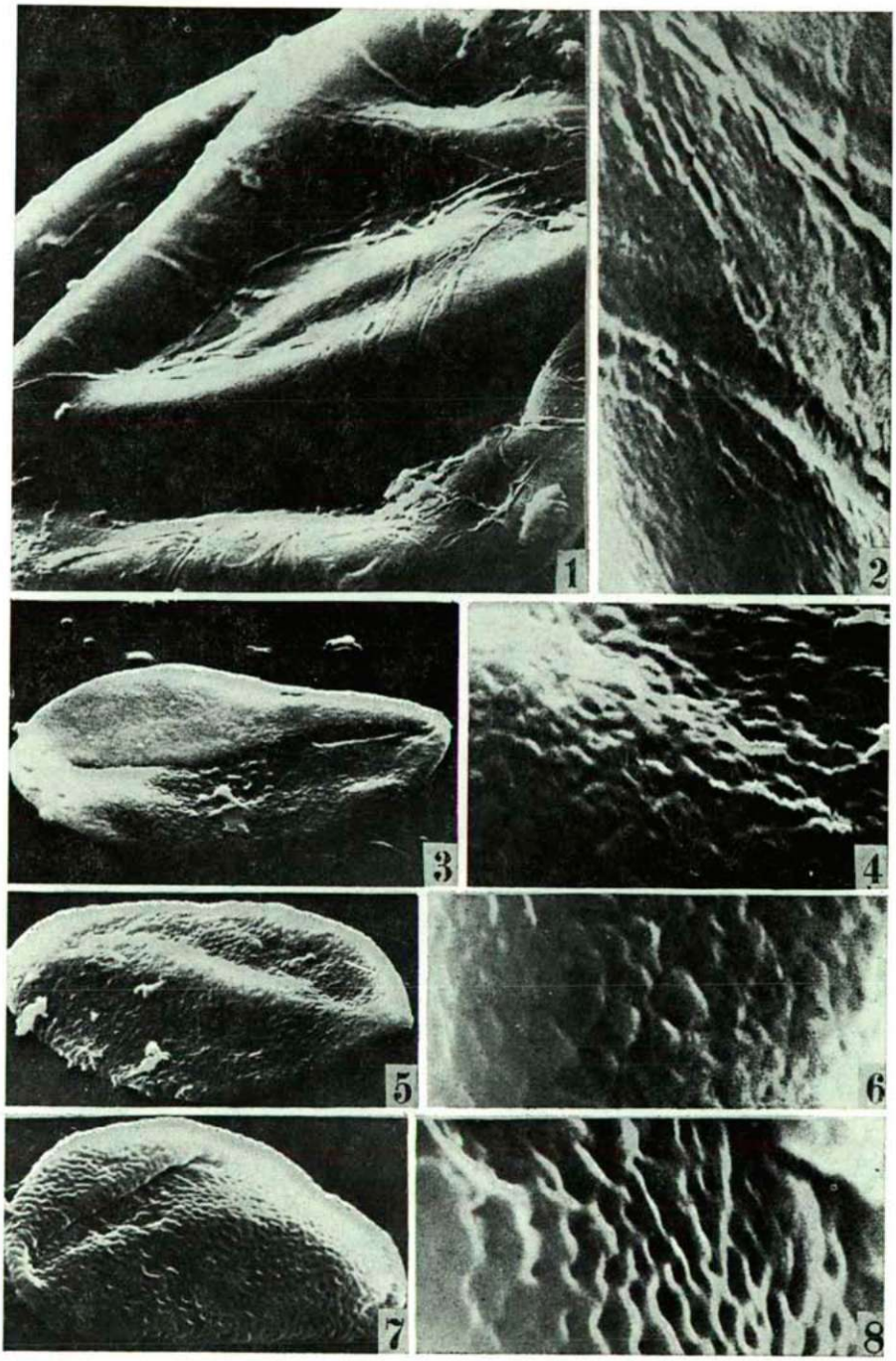
Discussion of results

Sporomorphes of different types have got under a scanning electron-microscopical investigation. Comparing our results in respect of spores with several literary data, we are led to the conclusion that in the future only the results of investigations with a strong magnification can bring something that is even qualitatively new, face to face with the light-microscopical results. On the conspicuous ornamentations which can be recognized with light microscopes, as well other formations may also take place. But primarily the spores with surfaces that seem to be smooth with light microscopes are those at which submicroscopical surface formations of taxonomical value are possible, for which the investigated two *Leiotriletes* fsp. mean a good example. *Polypodiaceoisporites speciosus* is illuminating from this point of view, particularly the express submicroscopical ornamentation of the cingulum which seems to be smooth.

Plate III

1. *Psophosphaera intrapunctata* (KDS. 1961) n. comb.; a detail of the surface x2000.
2. *Psophosphaera intrapunctata* (KDS. 1961) n. comb.; a strongly magnified detail of the surface sculpture, x10 000.
3. 5. *Monocolpopollenites tranquillus* (R. POT. 1934) TH. et PF. 1953 subfsp. *tranquillus*, Palmae; the surface ornamentation of full pollen grains, x2000.
4. 6. *Monocolpollenites tranquillus* (R. POT. 1934) TH. et PF. 1953 subfsp. *tranquillus*, Palmae; a detail of the submicroscopical ornamentation of the surface, x10 000.
7. *Arecipites granulatus* (KDS, 1961) L. RÁKOSI 1973, Palmae; SEM photograph of the pollen grains, x2000.
8. *Arecipites granulatus* (KDS. 1961) L. RÁKOSI 1973, Palmae; a detail of the ornamentation of the surface, x10 000.

Plate III



Psophosphaera intrapunctata forms a part of our effort, to clear up the taxonomical, phylogenetical connections between the often uncertain, "inaperturate" forms. Our present-day datum presents only an aid to the further steps because on the basis of the demonstrated surface formations the gymnospermous, but also the Pteridophytic origin may be exclused. It may have been the leftover of the fossil Cormophytic taxon but we may think on an algal origin, too. Concerning the scanning data of the recent, resp. fossil inaperturate gymnospermous pollen grains, the works of REYRE (1968, 1973), SRIVASTAVA (1975) afford a very good comparative material.

The knowledge of the submicroscopical surface of the Palmae pollen grains may lead to the determination of the genus. THANIKAIMONI (1966, 1970) performed several investigations into recent Palmae pollen grains, applying both the *TEM* and *SEM* methods. In spite of this, the electron-microscopical knowledge of the recent Palmae pollen grains cannot be considered at all as closed and, owing to the deficiency of the recent comparative SEM data, the identification of the genus could not be carried out. On the other hand, on the basis of the results of the complex researches of AUDRAN and MASURE (1977) into Cycadales pollen grains, the possibility of the belonging of *M. tranquillus* into this group — that on the basis of the light-microscopical morphology, as a possibility, could so far emerge — may now be regarded as precluded.

By POTTER, JR. (1946), the scanning electronmicroscopical picture of cf. *Monocolpopollenites tranquillus* was published from the sediments of the Eocene of Kentucky and Tennessee (Pl. 6, fig. 142). This pollen grain fundamentally differs from those recognized from the Dorog basin, as its tectum is smooth and perforate. In this case, therefore, different species are, at any rate, in question. The question is made interesting by that in Plate II, pictures 12–15 the light-microscopical pictures of *Monocolpopollenites tranquillus* are published by POTTER, JR., on the basis of which no essential difference can be found between the specimens of the Dorog basin and those of North America. The "tranquillus Palmae pollen", the importance of which is indisputable, is from the point of view of the palaeogenous vegetation, on the basis of the recent, already mentioned, light-microscopical data, very problematical. KRUTZSCH (1962) described the subfsp. verrucatus and remarked that the main subfsp. is not entirely smooth but finely sculptured, extrapunctate, granulate but never finely reticulate one. In his opinion, a finer morphological analysis may lead, at these so-called "smooth Palmae pollen grains", to a further division. The author (1968) described, in the course of the palynological investigation into the palaeogenous sediments of the Paris basin, three new subfsp. with light-microscopic method. KEDVES & BOHONY (1966) performed the size-variation-examination of *M. tranquillus tranquillus* and *Arecipites granulatus* (KDS. 1961) L. RÁKOSI 1973 from the Dorog basin. In case of *M. tranquillus tranquillus* has also the idea arisen that it is taxonomically heterogenous as the size-variation curve has three maxima. This is contradicted, in some degree, by that at the comparative recent *Martinezia caryotaefolia* KUNTH two maxima could be observed. This problem is supported by our above-mentioned scanning data, as well.

We shall finally deal with the work of NICHOLS, TATE AMES & TRAVERSE (1973) that continues complicating the question which is anyway in motion. They have investigated with light-microscopical method the question of *Arecipites* WODEH. 1933, *Monocolpopollenites* THOMSON et PFLUG and *M. tranquillus*. In their opinion,

Arecipites are "exine psilate to finely foveolate or scrobiculate"... They have classified into the here described *A. pseudotranquillus* NICHOLS, TATE AMES & TRAVERSE 1973, among others, the data from Hungary, published under the name *M. tranquillus* as well. It is interesting that the exine of the species is "faintly scabrate". About the surface of *M. tranquillus,* they write that it is "psilate scabrate or reticulate but not granulate or verrucate". The problem is, therefore, the separation of the form-genera *Arecipites* and *Monocolpopollenites*. The reexamination of the question with an electron microscope may mean a solution first of all on the original Geiseltal material in this question which is very complicated from taxonomical point of view.

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PALYNOLOGICAL EVALUATION OF THE HOLOSTRATOTYPE OF THE EGERIAN

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Abstract

The holostratotype of the Egerian Stage has been recovered in borehole and in the clay pit of the Wind's brick-yard at Eger (northern Hungary).

On the basis of palynological evaluation of the samples the following could be determined:

In the borehole in the Middle Oligocene and conformably overlying Egerian layers marine planktonic organisms and a characteristic Oligocene paleotropical flora has been preserved.

From the lower samples of the brick-yard pit (lower flora) very scarce Late Oligocene plankton and flora elements were collected.

In the upper samples of the brick-yard pit (middle and upper flora) beside paleotropical elements the consistent presence of arcto-tertiary elements is also characteristic.

The Egerian Stage was established for the Central Paratethys area in 1968 by T. BÁLDI and J. SENEŠ, in order to iron out difficulties in defining the Upper Oligocene-Lower Miocene boundary (Chattian-Aquitanian) — a problem that had been heavily disputed for a long time (T. BÁLDI and J. SENEŠ 1975. p. 9). The clay pit of Wind's brick-yard at Eger and the borehole of 80 m depth spudded into it were designated as holostratotype (1. c. p. 99).

The section of the holostratotype was subjected to palynological analyses. In a brief paper with co-author I. PÁLFALVY, the present writer reported on the results of their sampling made together with him (NAGY—PÁLFALVY, 1963) and, in addition, she described some new species (NAGY, 1963).

The present report is the first evaluation ever published of the results of the combined examination of the borehole drilled in 1961 in the brick-yard and the samples recovered from the clay pit there.

Materials and Methods

Geological Review

The Egerian of the lithological log recovered from the borehole in the brick-yard shows a conformable development from the Middle Oligocene. The Middle Oligocene Kiscell Clay (80.3—36.2 m) is overlain, from 36.2 to 18.0 m by Egerian glauconitic, tuffitic sandstones, followed higher up, from 18.0 to 0.0 m, by molluscan clays. In the geological section of the clay pit, the afore-mentioned clays with molluscs continue, attaining a total of 48 m in thickness taken combined with their share in the lithological log (BÁLDI, 1975), being followed by a sequence of clays and sandstones (15 m). The final member is constituted by sands and brackish-water or limnic clays and pebble (40 m) (BÁLDI, 1975). According to I. PÁLFALVY (1963), rhyolite tuffs are at the top of the sequence.

In the course of her palynological studies, the author evaluated a total of 58 samples distributed, according to their origin, as follows:

lithological log:
Middle Oligocene Kiscell Clay — 6 samples
Egerian glauconitic-tuffitic sandstone — 2 samples
molluscan clays — 10 samples
clay pit:
molluscan clays, siltstone lenses,
Bed X_2 and Bed x_1 (lower flora) — 2 samples
sequence of clays and sandstones (middle flora) 1 sample
brackish-water to limnic formation
overlying the sands (upper flora) — 37 sample

Results

The samples involved in palynological analyses are evaluated in the order of succession of that lithological section, quite clear and illustrative, published by T. BÁLDI (1966). Numbered from 1 to 20, Báldi's stratigraphic units encompassing a total of about 160 m thickness may be characterized by the following palynological assemblages:

The sample of the 79.8–80.3 m interval of the log derives from Bed 1 of BÁLDI. Constituted by *Middle Oligocene* Kiscell Clay, it cannot contain too much palynological material. The palynological data are indicative of marine sediments (e. g. *Pleurozonaria stellulata* (COOKS. et MANUM 1960) MÄDLER 1968. The sedimentation seems to have taken place rather far off-shore, as evidenced by the scarcity and small size of Angiospermae and the occurrence of small-size wind-bladdered coniferous pollen grains.

The sample deriving from the marl layer, Bed 2, (51.2–51.5 m) has yielded, similarly to the former, few palynological data, indicating the presence, beside a few Coniferae, of *Alangiopollis sibirica* (LUBOMIROVA 1972) and Sapotaceae species. Taken from these same marls, the samples of the 50.3–50.9 m interval show extremely rich pollen spectra and contain a good deal of organic matter. Of the planktonic organisms, *Deflandrea spinulosa* ALBERTI 1959 shares 0.9%, *Cordospaeridium inodes* (KLUMPP, 1953) EIS. ssp. *minus* MORG. 1966 — 0.9%, *Achomosphaera* cf. *grallaeformis* (BROSIUS 1963) DAVEY et WILLIAMS 1966 — 1.8%, *Hystrichokolpoma cinctum* KLUMPP 1953 — 0.9%, *Pleurozonaria concinna* (COOKS. et MAN. 1960) MÄDLER 1968 — 4.5%, microforaminifera — 3.6%. The share of marine planktonic organisms sum total is 20.7%. Out of fern spores, it is *Cicatricosisporites chattensis* W. KR. 1961 *minor* W. KR. 1967, *Cicatricosisporites cicatricisoides* W. KR. 1959, of the Angiospermae pollen grains it is *Moncolpopollenites dorogensis* KEDVES 1961 that rise up into the Egerian. The 25% figure of Coniferae is suggestive of the proximity of a highland range, the same holds true for the 44% figure of predominant angiospermous pollen grains. Among these there are relatively few tropical elements (Sapotaceae) which seem to have been ferns corresponding to the level of herbaceous plants (*Corrugatisporites multivallatus* (PFLUG 1933) NAGY, *Verrucingulatisporites* cf. *verrucatus* KEDVES 1961, *Polypodiisporites favus* (R. POT. 1931) R. POT. 1933). The 3rd Bed, the fine-sandy, galuconitic marls, were held by BÁLDI for a transitional Kiscellian-Egerian layer (1966).

The pollen spectrum of the sample from 46.0–46.6 m does not show any substantial change compared to the former. The preservation state of the fossils is not so good, as implied by the lithologic composition of the sediments enclosing them

The presence of an Oligocene sea is indicated by *Deflandrea spinulosa,* larger *Pleurozonaria concinna,* a few fragments of Hystrichosphaeridae. The proximity of land is suggested by the subequal amount of coniferous and deciduous pollen grains. The occurrence of a species of transition between *Cedripites oligocaenicus* and *C. lusaticus,* in terms of morphology at least, and that of *Momipites quietus* (R. POT. 1934) NICHOLS is worth mentioning. The presence of *Tricolporopollenites cingulum* (R. POT. 1931) TH. et PF. 1953 ssp. *oviformis* (R. POT. 1931) TH. et PF. 1953 massula, *Corrugatisporites multivallatus, Gleichenia* and *Polypodiaceoisporites* refers to an environment not too far off-shore.

The glauconitic sandstones constituting the 4th Bed (44.8–36.2 m) is barren (sterile). It is from the 5th Bed up, i. e. from 32.2 m on, that T. BÁLDI considers the sequence to be Egerian in age.

The first of the two samples recovered from the 5th Bed (31.9–32.5 m) is constituted by glauconitic, tuffitic sandstone. Its planktonic species are suggestive of a marine Oligocene, too: *Cordosphaeridium cantharellum* (BROS. 1935) DAVEY and WILL. 1966 and microforaminiferal remains. *Sapotaceoidaepollenites microellipticus* (PF. 1953) n.c. is that which might be quoted as a paleotropical element. The terrestrial vegetation is represented by a pollen spectrum similar, in composition and proportions, to the former. (21.5–21.9 m): marine planktonic organisms like *Deflandrea spinulosa,* fragments of Hystrichosphaeridae, *Pleurozonaria concinna* and microforaminiferal remains. Coniferae constitute 60% of the spectrum suggesting an environment farther off-shore. Among the representatives of Angiospermae, *Plicatopollis plicatus* (R. POT. 1934) W. KR. 1962, *Cyrillaceaepollenites megaexactus* (R. POT. 1931) R. POT. 1960, *Sapotaceoidaepollenites* sp., *Polypodiisporites alienus* (R. POT. 1934) NAGY 1973 and *Osmundacidites primarius* (WOLLF, 1934) NAGY ssp. *oligocaenicus* W. KR. 1967 are thermophile plants of Oligocene character. Such characteristic forms as *Caryapollenites simplex* (R. POT. 1931) R. POT. 1960, *Pterocaryapollenites* sp., *Tricolporopollenites cingulum* ssp. *oviformis* are suggestive of warm-to-temperate riparian vegetation.

From Bed 6, the author has examined 10 samples recovered from molluscan clays. The microforaminifera of the sample from the 17.6–18.3 m interval still refer to a sea environment, but the coastline must have been closer in this case compared to the previous sample, as Angiospermae are present in much greater proportion than Coniferae. Among these both Sapotaceae and *Engelhardtia* can be found, though *T. cingulum* ssp. *oviformis* and Juglandaceae are also represented. A few ferns can also be observed *(Gleichenia, Selaginella).*

The sample of the 16.8–17.2 m interval, from the same complex, is of similar composition, though it contains a poorer flora.

The sample recovered from the 13.1–13.4 m with *Pleurozonaria concinna* is typically marine, the ratio of Coniferae and Angiospermae pollen grains being similar to the case of the former 2 samples. Among the representatives of Coniferae, *Podocarpidites* sp., among those of Angiospermae *Tricolporopollenites spinus* W. KR. 1962, *Sapotaceoidaepollenites* sp., *Cyrillaceaepollenites exactus* (R. POT. 1931) R. POT. 1960 and *Subpolycolporites minor* RÁKOSI 1973 are worthy of mention. The few fern spores and coal fragments and detritus of vegetal tissue are suggestive of a near-shore environment. The presence of *Pleurozonaria concinna* and a broken specimen of Hystrichosphaeridae in the 10.9–11.10 m interval are indicative of seawater. In the thermophile littoral forest close to the water's edge it is elements

suggestive of Fagaceae — in addition to Sapotaceae, *Araliaceoipollenites edmundi* (R. POT. 1931) R. POT. 1960, *Engelhardtioidites microcoryphaeus* (R. POT 1931) R. POT. 1930 — that are predominant. Of the fern species it is *Leiotriletes triangulatoides* W. KR. 1962, *L. wolffi* W. KR. 1962 wolffi, *Gleicheniidites, Polypodiisporites alienus, Verrucingulatisporites undulatus* NAGY 1963 that prove the presence of a near-shore environment.

The material of 9.2–9.7 m is very rich, typical of the Upper Oligocene, 78% being constituted by Angiospermae of which the share of *Pentapollenites regulatius* W. KR. 1962 is 2.8%, that of *Plicatopollis plicatus* being again 2.8%, that of *Rhoipites pseudocingulum* (R. POT. 1934) R. POT. 1960 2.1%, *Cyrillaceaepollenites exactus* 1.4%, *Sapotaceoidaepollenites* sp. 2.8%, *Engelhardtioidites* 1.4%, *Intratriporopollenites insculptus* MAI 1961 0.7%, *Tricolporopollenites cingulum* (R. POT. 1931) TH. and PF. 1953 ssp. *fusus* TH. and PF. 1953 attaining almost 30%, *T. microhenrici* (R. POT. 1931) W. KR. 1964 almost 7%, *T. cingulum* ssp. *oviformis* 3.6%. The presence of a swamp forest is corroborated by the occurrence in 4.9% of *Taxodiaceaepollenites,* in addition to *Nyssapollenites* present in 2.8%, *Myricapollenites* in 0.7% and *Alnipollenites* in the same percentage. Fagaceae and quercoid forms are frequent. The share of *Fagus* is 0.7%, that of *Tricolporopollenites dolium* (R. POT. 1931) TH. et PF. 1953 and *T. villensis* (THOMS. 1950) TH. and PF. 1953 as well as Betulaepollenites and *Carpinus* being 1.4%. Underwoods are represented by *Artemisia,* Ericaceae, spores by *Cicatricosisporites cicatricosoides, Leiotriletes maxoides* W. KR. 1962 ssp. *maximus* (PF. 1953) W. KR. 1959, *Polypodiisporites favus, Polypodiaceaeoisporites miocaenicus* NAGY 1969, *Laevigatosporites haardtii* (R. POT. et VEND. 1934, TH. et PF. 1953, in valuable quantities. Paleotropical *Dicolpopollenites calamoides* NAGY 1963 is also present (0.7%). Beside *Sparganiaceaepollenites,* forms suggestive of freshwater (0.7%), the presence of marine sediments is suggested by *Cordosphaeridium inodes* (KLUMPP 1953) EIS. 1962 and *Pleurozonaria concinna.* The sample contain hosts of allochtonous elements, in addition to a great deal of Normapolles there occur a few Triassic Corollina specimens, possibly undergone redeposition even secondaryly, as well.

From the 8.3–9.2 m interval the author studied 2 samples, of which sample "b" taken from the deeper part (more calcareous) contains few pollen grains and spores, while sample "a" is again very rich in sporomorphs. Out of the marine planktonic organisms there are few Hystrichosphaeridae and more *Pleurozonaria* species such as *P. concinna, P. manumi* (KRIVÁN—HUTTER 1963) n. c. (*Crassosphaera manumi* KR.-H. 1963) and *P. minor* (KRIVÁN—HUTTER 1963) n. c. (*Crassosphaera minor* KR.-H. 1963). Angiospermae constitute 82% of the pollen spectrum, of which nearly 50% are *Tricolporopollenites cingulum* ssp. *fusus,* and with *T. cing.* ssp. *oviformis* added to, it accounts for 74% of the spectrum. Most of the species reach up to the Miocene: *Intratriporopollenites insculptus, Pentapollenites regulatius* (6.7%), *Cyrillaceaepollenites exactus, C. megaexactus, Tricolpopollenites liblarensis* (THOMS. 1950) TH. and PF. 1953 ssp. *liblarensis* and *T. liblarensis* (TH. 1950) TH. and PF. 1953 ssp. *fallax* (R. POT. 1934) TH. and PF. 1953 and *Tricolporopollenites microhenrici.* Sapotaceae pollen are present in more than 5%, being admixed to by *Monocolpopollenites tranquillus* (R. POT. 1934) TH. and PF. 1953, thus determining the Late Oligocene character of the flora. Arcto-Tertiary elements do also occur: quercoid forms, *Fagus, Salix* and Chenopodiaceae pollen grains.

Coniferae are insignificant (7.8%). Most of the spores are present in the Miocene sediments as well *(Polypodiisporites alienus, P. favus, Leiotriletes maxoides maximus)*

and some *Verrucingulatisporites* and *Polypodiaceaepollenites* species. Redeposition in the case of this sample must have taken place in Snonian times. The climate in this case cannot be said to have been cooler than subtropical, as the botanical implications of *Tricolporopollenites cingulum* occurring in great quantity are quite obscure.

The sample from the 7.8–8.3 m interval is extremely rich in fossil floral remains. Fragments of cf. Lingulodinium sp. and *Pleurozonaria concinna* represent the marine plankton. The proportions of Coniferae, Angiospermae and spores are similar to the case of the previous samples. *Microfoveolatosporites sellingi* W. KR. 1967 occurs here as a new element (1.8%). The great quantity of coal and organic plant detritus and remnants of vegetal tissue are suggestive of a near-shore environment. On occount of the more calcareous lithology of the samples recovered from the 6.1–6.4 m and 4.0–4.4 m intervals the quantity of spores and pollen grains is more reduced in them, though these do not differ from the spores, pollen grains and planktonic organisms of the former samples. Not even the presence of allochtonous forms does suggest a change in environment, and it is rather to the upper rich pollen spectra of the borehole that they resemble to in this respect.

The lower samples of the *clay pit of the brick-yard* have been recovered, according to the instructions of F. LEGÁNYI and I. PÁLFALVY, from siltstones interbedded with molluscan clays on the northern margin of that part of the clay pit exposed in 1960 (Bed 6 of BÁLDI). In this part that was referred to as "lower flora" by LEGÁNYI leaf remnants are rather few. The lower sample, x_2, contains an extremely rich pollen spectrum. In contrast to the samples recovered from the borehole, it is Coniferae that are predominant, with 74.1%. In addition to hosts of *Pityosporites labdacus* (R. POT. 1931) TH. et PF. 1953 and *Abietinaepollenites microalatus* (R. POT. 1931) TH. et PF. 1953, the almost 5% share of *Podocarpidites* and the occurrence of some age-diagnostic forms such as CEDRIPITES cf. VERRUCULATUS (*Trevisan* 1967) W. KR. 1971 and *C. miocaenicus* W. KR. 1971 that are worthy of mention. In addition to thermophile species (Sapotaceae, Cyrillaceae, Engelhardtia), Angiospermae (17.2%) include arcto-Tertiary elements *(Betula, Fagus)* as well. The mother plants of the spores in this case seem to have been rather thermophile elements (*Leiotriletes maxoides maximus, Mecsekisporites cerebralis* NAGY 1969, Osmundacidites, *Polypodiaceoisporites magdalenae* NAGY 1969).

The upper sample, x_1, too is extremely rich, though different from x_2. Angiospermae constitute 83.6%, Coniferae and Pteridophyta 8% each, in it. *Podocarpus* is represented with 2.1%, *Podocarpidites libellus* (R. POT. 1931) W. KR. 1971 is even age-diagnostic.

Among Angiospermae *Tricolporopollenites cingulum* ssp. *fusus* (10%) is predominant. The spectrum is rendered more varied by the presence of subtropical and tropical elements: *Cyrillaceaepollenites exactus* (3.5%), *C. megaexactus* (2.8%), *Engelhardtioidites* (2.8%), *Sapotaceoidaepollenites* (2.1%), *Plicatopollis plicatus, Araliaceoipollenites euphorii* (R. POT. 1931) R. POT. 1951, *Arecipites, Magnoliaepollenites* and *Ilexpollenites margaritatus* (R. POT. 1931) R. POT. 1960.

Juglans, Carya, Tricolporopollenites asper (TH. et PF. 1953) W. KR. 1961, *T. microhenrici* and *Tricolporopollenites liblarensis* are arcto-Tertiary elements, and *Zelkovaepollenites* also appears. Characteristic spores are: *Corrugatisporites multivallatus multivallatus, Favoisporites hungaricus* NAGY 1963, *Verrucatosporites saalensis* W. KR., 1959, *Concavisporites discites* PF. 1953.

The fine molluscan sands of the 7th Bed are palynologically sterile. It is the clays of the 8th Bed that contain the so-called "middle flora" whose macrofloral elements are rather poorly preserved. The microflora is very abundant. Coniferae are predominant with 54.4%, Angiospermae account for 36% of the spectrum, spores contribute 10% to it. More than 15% of Coniferae are represented by *Pityosporites labdacus*, 9% by *Abietinaepollenites microalatus*, 3.2 by *Podocarpidites*, 2% by *Cedripites*, 1% by *Dacrydiumites*. Characteristic forms occurring here are *Pityosporites cedrisacciformis* W. KR. 1971 and *Pityosporites minutus* (ZAKL. 1957) W. KR. 1971, too. Angiospermae are represented by many species, but the single species include few specimens. Of the paleotropical species we might mention *Engelhardtia*, *Plicatopollis plicatus* (2.4%), *Myricipites* (4%), Palmae (0.8%). Arcto-Tertiary elements are: *Tricolpopollenites liblarensis* ssp. *fallax*, *Tricolporopollenites cingulum* (4%), *Ulmipollenites* (1.6%), *Zelkova* (1.6%), *Alnus* (0.8%). Among the spores, *Echinatisporites*, *Cicactricosisporites*, *Leiotriletes* sp., *Polypodiisporites cerebriformis* NAGY 1963, *P. alienus*, *Polypodaceoisporites*, *Laevigatosporites haardti* are most significant. The spectrum suggests a mountainous region close to the coasts with mixed piedmont subtropical deciduous forests and thermophile fern spores.

The 9th Bed is constituted by micaceous sands, the 10th Bed by sandstones, the 11th Bed by limonitic sandstones, the 12th by limonitic concretional clay-marls, the 13th by unconsolidated sandstones. All these are palynologically sterile. Beginning with the top of the 20-m-thick sand complex, the 14th Bed comprises the so-called "upper flora" — a rich macroflora. This 15–16 m interval has been sampled in great detail. A total of 37 samples were analyzed. They were taken at any change in lithology and examined from fine-stratigraphic considerations. 8 samples out of these could be evaluated in percentage terms.

The samples belonging to the 14th Bed (Sample 1–6) were palynologically barren, with single spores or fragments of Coniferae.

The first sample taken from the 15th Bed (Sample 7) was recovered from a greyish, sandy clay layer. The rich spectrum contains 55% Angiospermae, 33.5% Coniferae and 6.3% spores and a few planktonic organisms as well. Among the coniferous pollen grains there can be found even *Abiespollenites absolutum* THIERGART 1937, *Piceapollenites tobolicus* (PAN. 1966) W. KR. 1971, *Cedripites szaszvarensis* NAGY 1969, *Dacrydium* and *Glyptostrobus* species, suggesting partly a higher mountainous topography and partly a marshy environment. This latter is supported by the rather great number of *Myrica* (14%) as well. Paleotropical forms are: *Calamus* (3%), Sapotaceae and *Engelhardtia*, the relevant spores are *Cicatrisporites chattensis minor*, *Faviosporites hungaricus* NAGY 1963, *F. concavus* NAGY 1963, *Polypodiisporites favus*, *Laevigatosporites haardti*. In addition to these there are arcto-Tertiary species as well: *Alnus* (2.8%), *Betula*, *Acer*, *Zelkova*, *Carpinus*, *Carya*.

In the next clayey sample (Sample 8) the representatives of Coniferae are predominant: *Abietinaepollenites microalatus* (18%), but in the lower samples *Podocarpidites libellus* and a few *Cedripites* species can also be found. A paleotropical environment is suggested by *Araliaceoipollenites megaexactus* and a few spores: *Verrucingulatisporites undulatus*, *Leiotriletes*, *Polypodiisporites alienus*, *Polypodiaceoisporites gracillimus* NAGY 1963 and by *Gleichenia* species. The presence of *Sphagnum* spores still in massulae in a considerable number is suggestive of a marhsy-boggy environment. Arto-Tertiary forms: *Alnus*, *Zelkova*, *Ulmus*, are also present.

The so-called "upper flora" occurring in the sandy clays of the 16th Bed is

that which contains the nicest plant macrofossils. Only one of the 9 to 15 samples analyzed palynologically did not yield percentage results. These samples contain a very rich sporomorphous assemblage. Coniferae constitute in all samples more than 20% of the spectrum: *Pityosporites labdacus* and *Abietinaepollenites microalatus, Podocarpidites, Cedripites, Gingko, Sciadopitys* and *Tsugaepollenites igniculus* (R. POT. 1931) R. POT and VEN. 1934, *Piceapollenites tobolicus* are accompanied by *P. neogenicus* NAGY 1969 and *Abiespollenites absolutus.*

Among the representatives of Angiospermae the species *Dicolpopollenites calamoides* constitutes more than 13% of the spectrum, in other places it is *Myrica* that attains the same percentage, in Sample 12 even 20%. Additional paleotropical elements: Sapotaceae, *Monocolpollenites tranquillus, Plicatopollis plicatus, Engelhardtia, Cyrillaceaepollenites, Araliaceoipollenites edmundi.*

Of the spores it is *Osmunda* that attains 5–6% in the first samples, being complemented with *Gleichenia* and *Polypodiisporites favus.* The arcto-Tertiary elements are stabilized, though present in low percentage only (*Alnus, Zelkova, Ulmus, Carpinus, Acer,* quercoid forms and *Carya*).

Among the recent representatives of these genera there are still forms living under subtropical and warm-to-temperate climates. Also on account of the paleogeographic situation here, the local climate of this lagoonal, shallow-water littoral environment protected by higher mountain ranges could not have been colder than subtropical. The sandy and sandstone samples (Samples 16–19) of the 17th Bed are palynologically poor. It is in single, rather argillaceous, sand samples that a few pollen grains occur, just reminding of the rich floral spectrum of the previous samples.

The Samples 20–22, containing coalified plant fragments, of the 18th Bed are devoid of pollen grains. The argillaceous sand samples (No. 23–24–25), even though not evaluable in percentage terms, did provide some interpretable information. The presence of swamps is suggested by Taxodiaceaepollenites sp. and by *Nyssa* and *Sphagnum* spores *(Stereisporites stereoides). Engelhardtia,* Myrtaceae, *Symplocos,* first appearing here, and *Monocolpopollenites tranquillus* are paleotropical elements. The spectrum is complemented by *Tricolporopollenites microhenrici,* a few quercoid forms and some spores (*Leiotriletes adriensis, Polypodiisporites multiverrucosus* NAGY 1969, *P. alienus, Microreticulatisporites* sp., *Corrugatosporites multivallatus, Laevigatosporites haardti*). The assemblage is characterized by the fact that the material affected by selective fossilization in the sandy sediments enclosing it is suggestive of a quite near-shore environment: it includes the representatives of Taxodiaceae and massulae of *Carpinus* pollen.

The sandy samples that follow, SAMPLES 26–27–28–29, are almost barren, only single specimens of freshwater Ovoidites ligneolus R. Pot. are present in them.

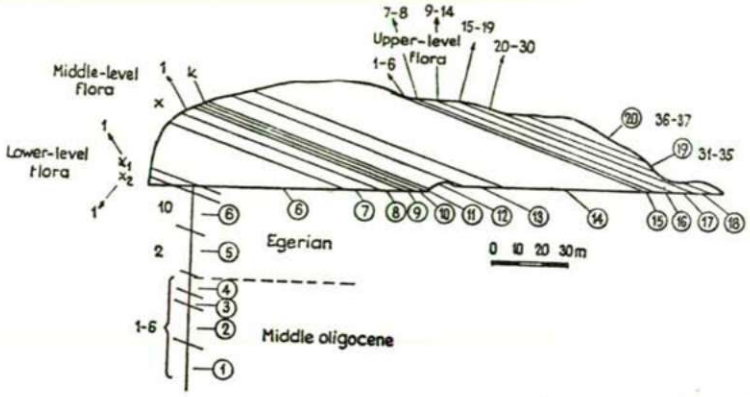
Sample 30 is a material of greenish colour, in which a few Coniferae (*Abies, Sciadopytis,* and 1–2 Angiospermae), *Myrica, Tricolporopollenites cingulum* and some spores, *Gleicheniidites microstellatus* NAGY 1963, *Gl. elegans* NAGY 1963, *Polypodiisporites alienus, Polypodiaceoidaesporites gracillimus,* have been preserved.

After a barren variegated clay sample (Sample 31), probably belonging to the 19th Bed, the clay sample (Sample 32) below the Mytilusbearing layer is that which has yielded the last rich pollen spectrum represented by Coniferae in 71.2% proportion of which 20% are *Abietinaepollenites microalatus* and 10.8% *Pityosporites*

labdacus. In addition to them, species of *Podocarpus, Tsuga* and *Cedrus* and 12% Taxodiaceae can be found.

Among Angiospermae, the share of *Engelhardtia* is more than 4%; besides it is *Monocolpopollenites tranquillus* and *Dicolpopollenites calamoides* that represent paleotropical elements. They are complemented by spores *Osmunda, Cicatricosisporites, Trilites hungaricus* NAGY 1963, *Polypodiaceoisporites gracillimus, Polypodiisporites favus, P. alienus,* etc. *Alnus, Juglans,* minor quercoid pollen grains, etc. may by regarded as representatives of arcto-Tertiary elements.

The three additional samples (No. 33, 34, 35) are barren, just as it is the case with the sand samples (Samples 36–37) which already seem to belong to Báldi's 20th Bed.



The holostratotype of the Egerian rests conformably on the Middle Oligocene. The Egerian material of the Middle Oligocene exposures and boreholes is characterized by marine planktonic organisms and a typically Oligocene paleotropical flora, including very few arto-Tertiary elements. The basal samples of the brickyard exposure (lower flora) already contain very few planktonic organisms and a latest Oligocene flora. The upper samples (middle and upper flora) are characterized by the consistent presence of arcto-Tertiary elements added to the paleotropical ones.

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Fig. 1. Localities of sampling in the Egerian sequence (After BÁLDI 1966).

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Plate 1

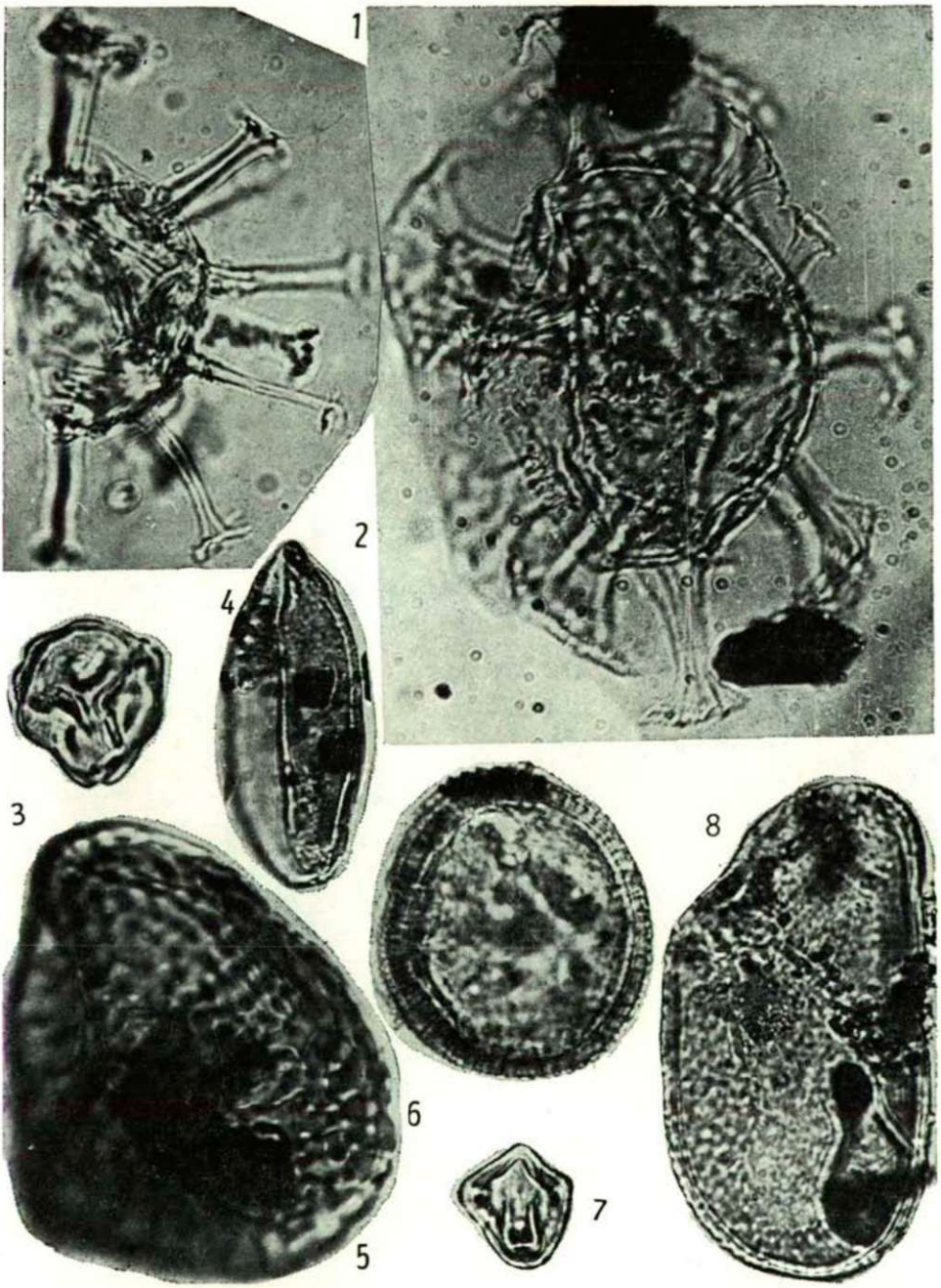
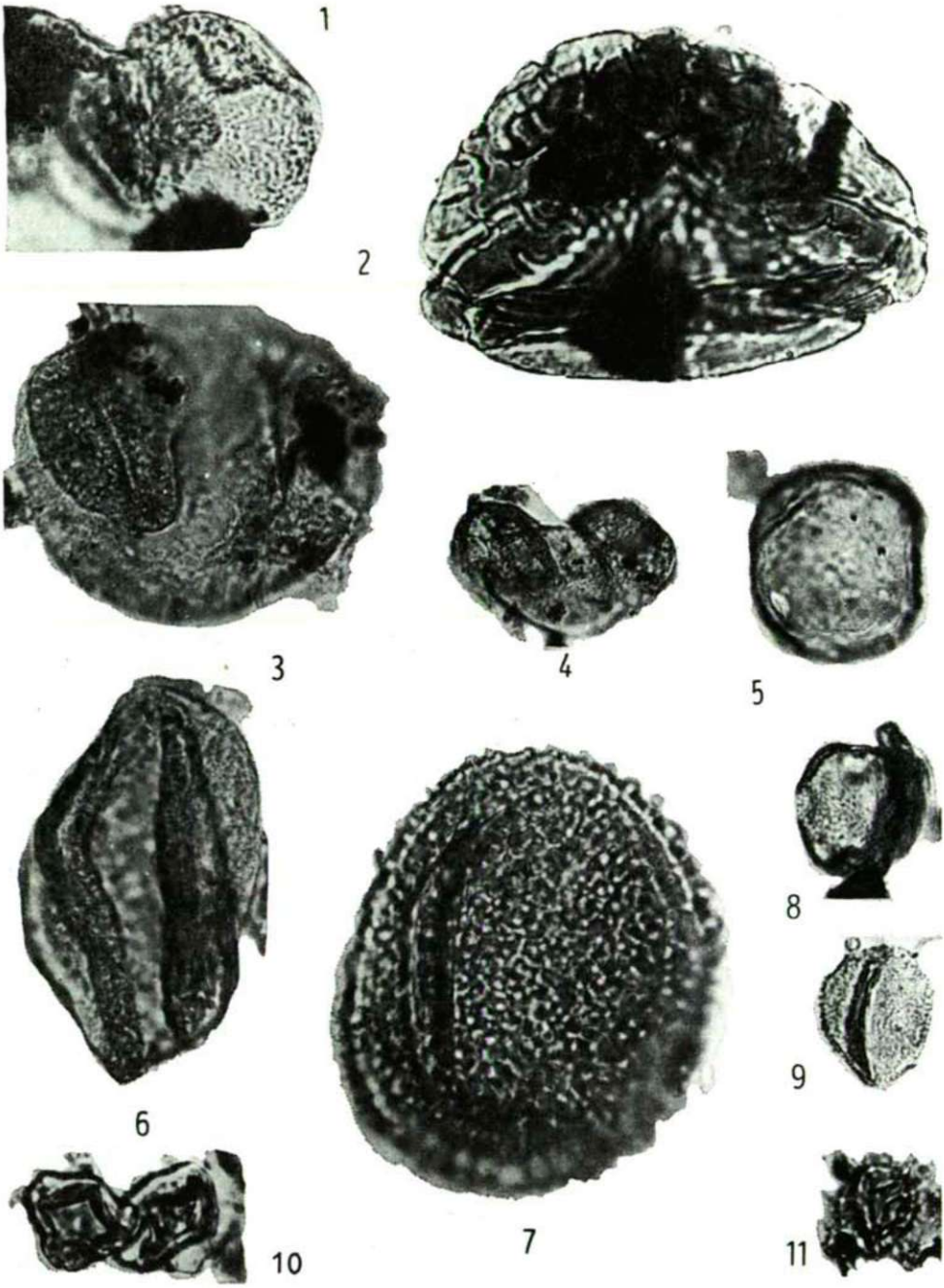


Plate 2



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In honour of Prof. PÁL GREGUSS
on the occasion of his ninetieth birthday

AZOLLA AND SALVINIA FROM THE PLEISTOCENE OF VÉSZTŐ (GREAT HUNGARIAN PLAIN)

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Abstract

From the Pleistocene deep-boring No. 1 at Vésztő, in the course of Ostracoda investigations, some Salviniaceae fossils came to light, namely

Salvinia sp. 1 megaspore (? S. natans foss.),
Salvinia sp. 2 megaspore,
Salvinia sp. microsporangium,
Azolla filiculoides LAM. foss. megaspore and massula,
Azolla tegeliensis FLORSCH. em. BERTELSEN, megaspore,
Azolla danica BERTELSEN, massula.

The sensitivity to the cold climate and facies-marking role of these species of the communities of plants floating on the water surface is indisputable. The determined *Azolla* megaspores and massulae mainly occur in the lower part of Pleistocene and indicate a climate corresponding to that of the interglacial periods.

In our material, they help us to divide the lower stage of Pleistocene in a greater detail, what could not be achieved on the basis of ostracods.

Introduction

In the course of the investigation of the microfaunistical samples of the deep-boring at Vésztő (in the Great Hungarian Plain: MARGIT SZÉLES), several Salvinia and *Azolla* megaspores, massulae, resp. microsporangia were found. The determination and evaluation of these induce the belief that — together with the existing Ostracoda and the future palynological examinations — the single stages of Pleistocene can be divided better stratigraphically and investigated facies-ecologically and climatically than at present.

In Hungary, but a few fossils of Salviniaceae could so far be found. From the old literature of the Carpathian basin, *Salvinia* leaves were demonstrated by STAUB (1881 and 1887) from the Aquitanian stages of Fruska-Gora and the Zsil-valley. *Salvinia* leaf fossils were similarly found in the Oligocene at Érd, as a result of the investigations by RÁSKY (1949). And from the middle Miocene macroflora in the environment of Eger-Tihamér, *Salvinia* leaves were demonstrated by IGALI ZELLER (1955).

In the recent palynological literature mainly Salviniaceae microspore fossils are reflected. E. NAGY described (1969) a microspore connected with *Azolla* from the Torton stage of Hídas (Mecsek mountains). The palynologist author of this paper has found *Hydrosporis* sp. microspores in more than one boring sample from the Miocene through the Pannonian till the Pleistocene, referring to *Azolla* or *Salvinia*.

MIHÁLTZ FARAGÓ (1973) found *Azolla* — having a part, according to him, "together with both microsporangium and glochidium" — in the Egyek-1 boring, at the limit of Plio- and Pleistocene, and interglacial stages of the Pleistocene.

We have no knowledge about that the Hungarian special literature rendered an account of any description of the *Azolla* or *Salvinia* megaspore and massula. It is worth, anyway, calling the attention to these because — in spite of the rich Pleistocene occurrences — the territory of Hungary is one of the missing links in Europe in this respect and because their macroscopical light- and electron-microscopical morphology is well-known and, at the same time, the research workers dealing with the washed material, can easily expose and determine these, too, apart from the shells of molluscs, ostracods, *Chara* oogonia and diatoms.

Materials and Methods

The material of our investigation originates from the deep-boring at Vésztő-1 which passed througt the Pleistocene from 22 till 520 m with core-boring. In the course of ostracod investigations, shell fragments of molluscs, embrional snail shells and, in addition to *Bythinia* opercula, oogonia of *Chara, Salvinia* and *Azolla* megaspores and massulae, as well as carbonized tiny wood fossils were found.

The *Salvinia* and *Azolla* examinations have only comprised the fossils of six samples from the depths 340–370 m and 430–450 m where these occurred in large masses and the ostracod fauna was poor (Table 2).

Knowing the varied methodics of isolation and exposure from Schwarzenholz's (1961) method of the separation with $H_2O_2-NH_4OH$ till Bertelsen's method with bromoform-alcohol (1972), we have applied the following method: From the washed material we have picked out the megaspores one by one and in unnumbered amount, as well as (owing to their limited number) 25 massulae, resp. microsporangia, under a "Cytoplast" (Zeiss) binocular stereomicroscope, with a sharp-pointed splinter of wood. The untreated fossils were examined and photographed with a Zeiss microscope illuminated from above. For examining and photographing certain details (massula, glochidium, microsporangium, microspore, megaspore-perine and exine), some preparations washed and cleared with Na-hypochlorite were used. If necessary, we have also investigated and photographed megaspores, microsporangia and massulae macerated with dissecting needles.

In this paper, the *Azolla* megaspore means — according to POTONIÉ (1956) and KEMPF (1969b) — the fossil that comprises the megaspore in the strict sense of the word, the gula originating from the megaspore perine, the floats connected with the gula, the parts of the sporangiodermis covering the point of the gula.

By *Salvinia* megaspore the megaspore body and the conical triple lamella covering the not visible gula are meant, without any other constituent (stalk, sporangiodermis) which don't—or only exceptionally do — occur in fossils.

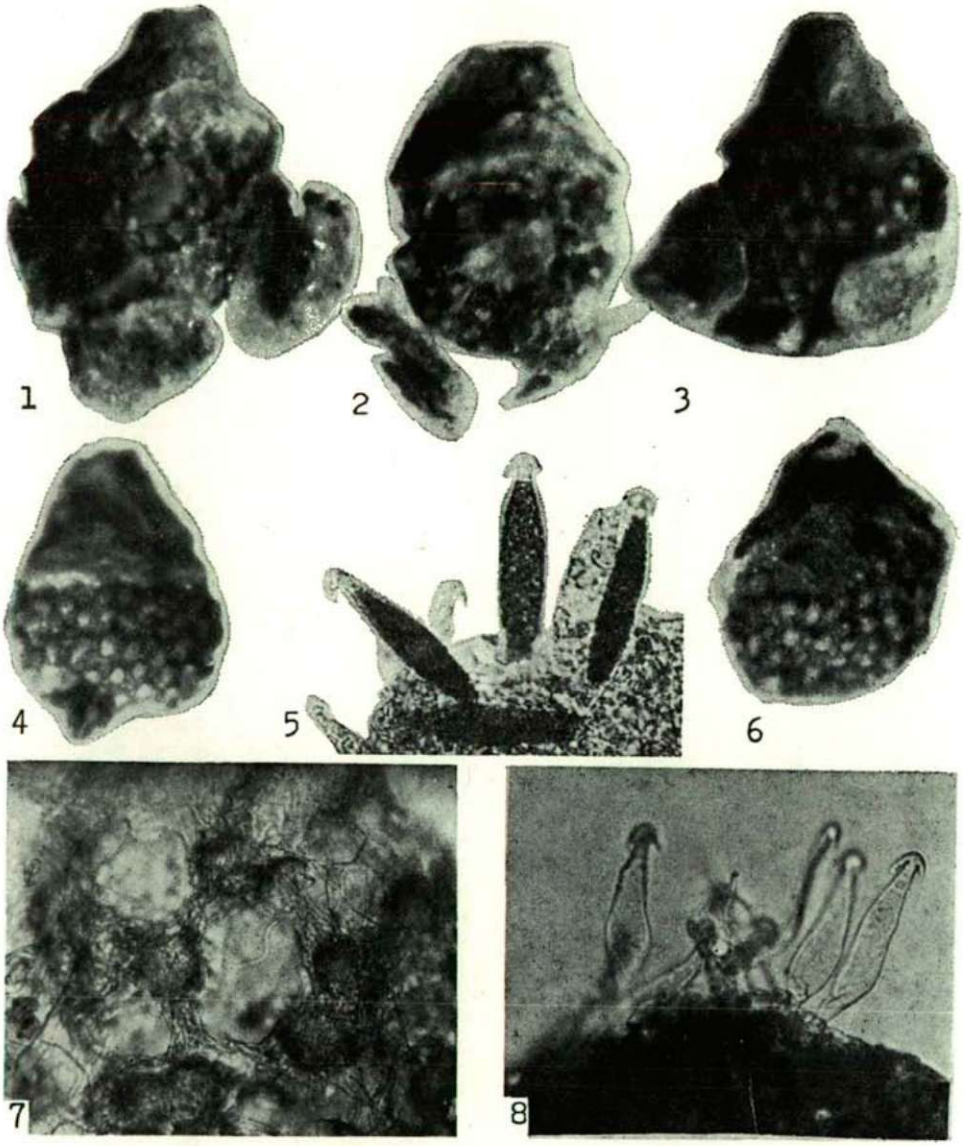
Microsporangium means the (stalked) organ of the *Salvinia* genus containing a single massula and that of the *Azolla* genus containing more massulae, surrounded with a sporangiodermis (SADEBECK in ENGLER-PRANTL, 1902). The microspongium of the Salvinia genus occurs isolated as a fossil. The *Salvinia* microsporangia contain microspore exines surrounded with a vacuolar wall. Massula means a formation of approximately spherical form, of tapetum origin and vacuolar structure, enclosing microspore exines. The hooked or hookless glochidia of the surface are formed from the material of the massula. The massula of the *Azolla* species occurs as a fossil, isolated or sticking to the megaspores.

Results

Azolla filiculoides LAM. foss. megaspore
(Plate I, photographs 1–4 and 6–7)

The megaspore is a ball with a conical apical part. As a matter of fact, the megaspore is formed by the ball. The conical apical part is formed by the elongated

Plate I



Figs. 1–4, 6: *Azolla filiculoides* LAM. foss. megapores and massulae, x100.
Figs. 5, 8: *A. filiculoides* massulae with anchor-shaped glochidia, x500.
Fig. 7: *A. filiculoides* perine with capilli, x500.

gula, the three floats connected with that, and by the sporangiodermis covering the apex of the gula.

The perine, the external wall of the ball, is verrucated. The verrucae are large, of 15–20 μm diameter and height. If illuminated from above, they are clear (e.g. Fig. I/4), at transillumination they are dark (Fig. I/7). The surface of the megaspore perine is woven with hairs, capilli.

The structure of the megaspore body is connected with different functions. The perine verrucae which consist of tiny vesicles, full of air and having very thin walls, play a part in keeping the megaspore at the surface of the water. Owing to their thin, membranous wall, they — and possibly the verrucae damaged by glochidia — mean gates for the penetration of spermatozoids. The perine seems, namely, at another place to be impenetrably compact. And owing to the perine capilli, the massulae can get entangled in it by their glochidia.

The polar axis of the megaspore (apparatus) is 350–490 μm, the maximum diameter of the megaspore body is 280–380 μm. These measurements agree with those given by HILTERMANN (1954), MÄDLER (1954), BERTELSEN (1972), and others. The 160–180 μm height of the conical apical part seems to be a more stable datum than that of the diameter of the megaspore.

At the contact of the megaspore body and the conical apical part the perine has no verrucae. Here the lower and upper parts are often separated from each other or may easily be separated. In this case, the perineless megapore exine falls out of it. The surface of the exine is granulated densely and finely. The laesurae of the trilete-mark are straight, 45–60 μm long. The diameter of the megaspore exine in preparations changed between 280–400 μm.

In the material, there occurred isolated exines, megaspore bodies consisting only of perine, and the fragments of the conical part comprizing floats, as well.

The massulae also occur, as a rule, stuck to the megaspores.

Azolla filiculoides megaspores and massulae occurred in samples taken from 361.76–362.22 m, 354.20–354.73 m, 344.48–345.31 m depth.

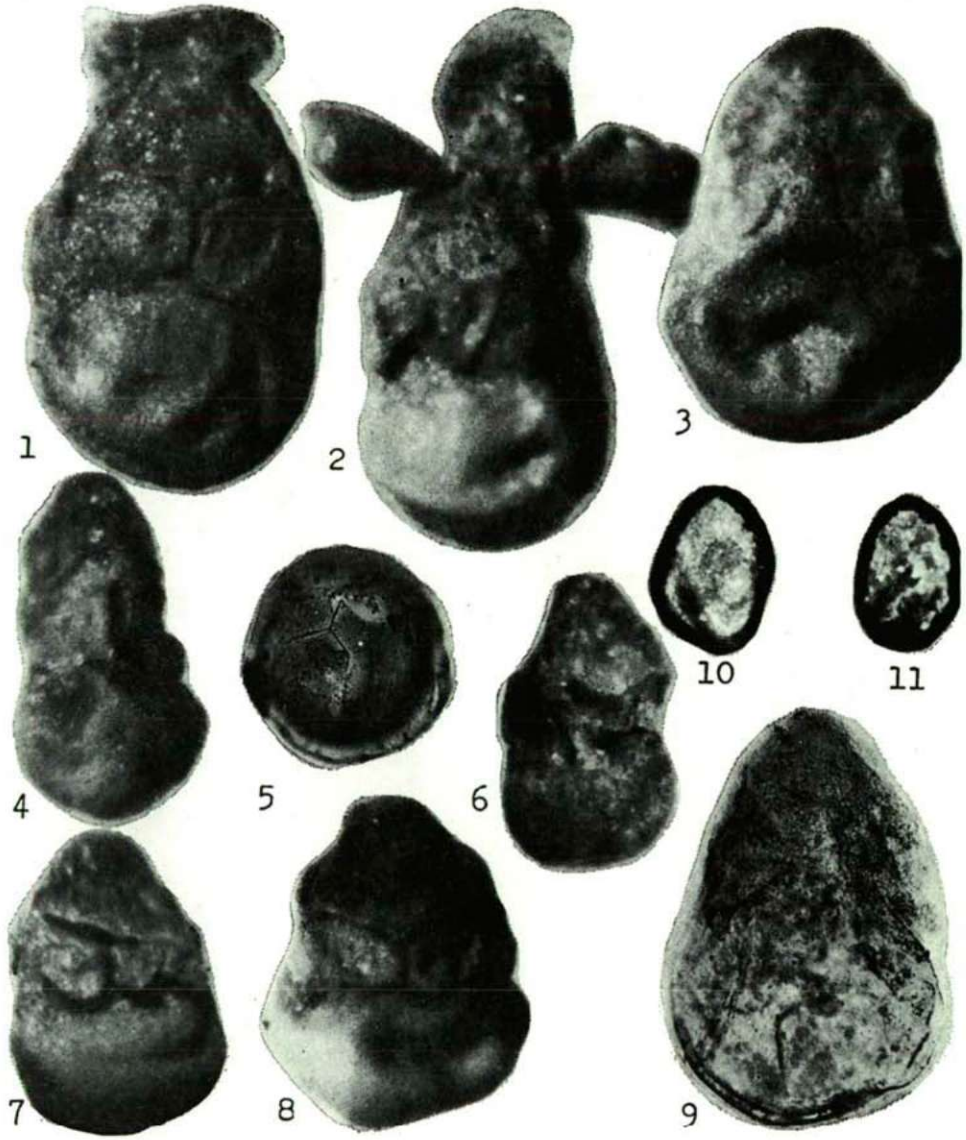
Azolla filiculoides LAM. foss. massula
(Plate I, photographs 5 and 8)

They are disk-shaped fossil bodies of a 135–190 μm diameter (without glochidium). Their substance is a vacuolar cell wall which corresponds to the perine of the microspore exines and originates from the tapetum of the microspongium. At their surface, there are anchor glochidia which are 56–80 μm long and their stalk has a maximum breadth of 8–10 μm. Under the about 10 μm wide hooked head, in the stalk, generally one septum, but rarely two septa, are to be found. The not septate glochidia are rare. Inside the massulae several microspores can be found with an about 18 μm diameter and with an about 1 μm thick, smooth exine. We did not succeed in observing the trilete-mark on the microspore. In Plate I, photographs 5 and 8 glochidia are demonstrated.

The *A. filiculoides* massulae generally occur connected with the megaspores (Plate I, photographs 1–3 and 6). It is rare if they are found isolated.

The perine-like material of massulae is extremely resistant. It endures even the rude pollen-exploring methods and materials. In pollen preparations, PACLTOVÁ (1960) and KRUTZSCH (1962) demonstrated fine glochidia and massula-pieces which probably don't belong to the *A. filiculoides* species.

Plate II



Figs. 1–4, 6–9: *Azolla tegeliensis* FLORSCHÜTZ em. BERTELSEN megaspores, x100.
Figs. 5: *A. tegeliensis* megaspore exine, x100.
Figs. 10—11: *Azolla danica* BERTELSEN massulae, x100.

According to the diagnosis of the recent *A. filiculoides* LAM (STRASBURGER 1873 in BERTELSEN 1972), "die Glochidien an den Massulae unseptiert", and at the var. *rubra*: "Die Glochidien der Massulae am Scheitel septiert". The distribution area of the former includes, according to SADEBECK (1902), the subtropic areas of the American Continent from California till the tropical, subtropical areas of Patagonia. And as the area of the septate variety of glochidia, Australia, New Zealand, and Tasmania are given.

The area of *A. filiculoides* foss. and of *A. interglacialica* NIKITIN, synonymous with it, extends from Northern Europe till Greece, from the Atlantic till about the Ural. Here is to be mentioned an occurrence from the Southern Banat, published by MÄDLER (1954) and touching Hungary, as well.

A. filiculoides foss. was considered by the old literature as an interglacial guide fossil of Mindel-Riss. The data collected from about 1928 till now were summarized by BERTELSEN (1972). According to these, the species occurs from Tiglian (Tiglian C substage) in the Waalian, "Cromerian", and Holsteinian interglacial periods and is the guide fossil of Holsteinian. And Holstein corresponds to the Mindel-Riss interglacial period. At evaluating the fossils stratigraphically, it is remarkable that it was found in the brown coal of Megapolis in Greece, as well, and — according to MÄDLER (1971) — the period of this is "die erste Wärmezeit des Pleistozäns". It was published similarly by BERTELSEN, that *A. filiculoides* must have become extinct in Europe, probably with the Saalian, as connected probably with the Saalian glaciation.

Azolla tegeliensis FLORSCHÜTZ emend. BERTELSEN megaspore
(Plate II, photographs 1–9, Plate III, photographs 1–2)

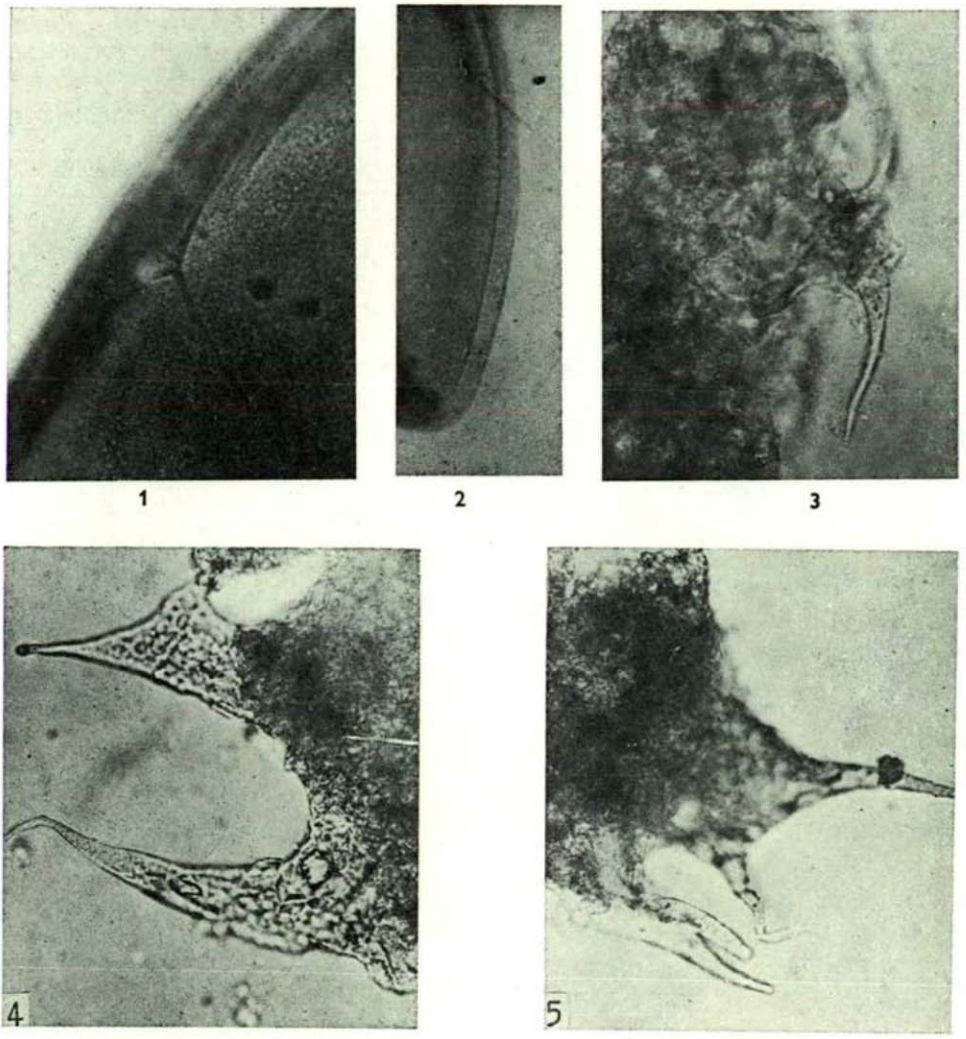
The megaspore has an ovoid shape. In its conical apical part, it has nine floats. On each concave side of the gula with triradial columella there are two diamond-shaped floats and above them and alternately a larger triangular float. The edge of the gula starts with an 8–10 μm wide basis but apically it grows narrow (Plate II, photographs 3 and 9). At the apex of the gula the so-called acrolamella is frequent with a number of capilli (Plate II, figs. 1–2).

The globular basal part, the perine of the megaspore body is comparatively smooth but in some grains the sporadically scatterred granules — which take a part in Bertelsen's emended diagnosis — can be seen even macroscopically (Plate II, photograph 3).

The perine of the basal part is elastic and can easily be broken with dissecting needles. The megaspore exine of a more solid wall can be prepared from it. The diameter of the megaspore exine is 250–300 μm (6 specimens). On it, there is a sharp-trilete-mark in a straight line. The laesurae of the trilete-mark are 40–60 μm long (Plate II, photograph 5 and Plate III, photograph 1). The exine is 3.2–4 μm thick and it seems to be of identical structure in the whole cross-section (Plate III, photograph 2). Its surface is granulate, with scatterred smooth spots (Plate III, photograph 1). The perine is 8–10 μm thick.

The sizes of megaspore vary between 380–680×240–410 μm. The height of the conical apical part is less variable (230–300 μm) than the *A. filiculoides*. The data of BERTELSEN (1972) don't move between so wide end values. Nevertheless, it is improbable that among the megaspores of nine floats one of the species described by DOROFEEV (1959, 1963b, 1968) also occurs.

Plate III



Figs. 1–2: *A. tegeliensis* megaspore exines, fig. 1: surface with tetrad mark, fig. 2: optical section, x500.
Figs. 3–5: *Azolla danica* BERTELSEN massulae with simple glochidia, x500.

In our material, *A. tegeliensis* occurs in large numbers in the samples originating from 339.88–450.00 m, 449.13–449.88 m and 433.67–433.91 m depths. In each of the samples in 361.76–362.22 m and 354.20–354.73 m depths there was found one specimen.

Azolla tegeliensis is, according to the data got till now, a fossil of extremely confined area. According to Bertelsen's investigations and the literary data (1972), it occurred in the Danish territory of the North Sea, in more than one habitat of Holland, in Öbel in Germany, as well as — according to the work of GREGUSS & VANHOORNE (1961) — in Belgium (Prof. PÁL GREGUSS determined the wood fossils of the lignite, originating from Saint-Leonard in Belgium, with the reliability characterizing him). In Kempf's paper (1969b) the thought presents itself that its area must have been larger than known until now.

It is noteworthy, at any rate, that *A. tegeliensis* can be found even about 1000 km south of these habitats.

As to the stratigraphy of the fossil, it is narrow enough, too. The Tiglian is only generally given or the embeddig rock is determined as Tiglian. In the work of GREGUSS & VANHOORNE (1961), it is written about the age of lignite that it is the "first interglacial of the Quaternary period". Rather exact data can be found in Bertelsen's work, too. According to the boring samples from the sector of the North Sea belonging to Denmark *Azolla tegeliensis* occurs beginning with the sporadic Reuverian fossils, through the Pretiglian, till the Tiglian. Its occurrence in the Waalian interglacial is uncertain. These are the sure facts.

With full knowledge of these facts, it is inexplicable how becomes this fossil in Dorofeev's and Triverdi & Verma's works (1971) a Pliocene species starting from the Miocene. FRIIS (1977) likewise present it in hers Table as a Lower Pliocene species, together with the species A. pyrenaica FLORSCHÜTZ & MENÉNDEZ AMOR (1960) which was similarly found at the Pliocene-Pleistocene boundary line.

Relying upon the right literary data dealing with this species, we consider *Azolla tegeliensis* as a fossil starting from the Pliocene-Pleistocene boundary and being wide-spread till the Upper Tiglian, the scattered specimens of which can also be found in the Waalian interglacial period and occur from the Upper Tiglian together with the *Azolla filiculoides*, as well.

Azolla danica BERTELSEN massula
(Plate II, photographs 10–11, Plate III, photographs 3–5, and Plate IV, photographs 9–11)

Massulae are irregular, ovoid formations, their surface is uneven, their thickness is changing. Glochidia without anchor, branching or not-branching off, stick to the surface in few places (it seems that at two points) (Plate III, photograph 3). Preparing the massula with needless, it turns out that the basis of glochidia agrees with the vacuolar structure of the massula body, the end of glochidia is only an inarticulate straight, reclinate or spiral hairlike formation (Plate III, photographs 4–5).

The diameter of massulae is 120–250 μm, the length of the non-vacuolated ends of glochidia is about 35–60 μm, and their surface is smooth.

The microspores in massulae (Plate IV, photographs 10–11) have a 19–22 μm diameter, their equator-contour is a circle. The laesura of the trilete-mark is 5–6 μm. On the surface of massula, where a microspore is in the massula, the wall of massula

(perine) creates a reticulum (Plate IV, photograph 9), the mess sizes are 1–5 μm, on average 2 μm wide.

The massulae occur isolated in samples containing several specimens of the *Azolla tegeliensis*. From among these, 12 specimens were prepared. In two cases, we succeeded in detaching from the acrolamella of *A. tegeliensis* some granules that proved to be *A. danica* massulae. This verifies the supposition (BERTELSEN, 1972) that *Azolla danica* is the massula of *A. tegeliensis*.

In our material, they occurred but in a low number in the samples originating from the depths 449.88–450.00 m, 449.13–449.88 m, and 433.67–433.91 m.

A. danica massulae have so far been found only in the Danish area of the North Sea in a depth of about 280 m below sea level, from a sample of *A. tegeliensis* above "maximum", from the upper Tiglian interglacial period where already *A. filiculoides* appeared, too. Their occurrence in Hungary is an important evidence in proof of the wide area.

Salvinia sp. 1 megaspore
(Plate IV, photograph 12)

The megaspore, having but few determinative marks, is approximately spindle-shaped. Its lower part, the megaspore body, is smooth, somewhat rugose. Between the conical apical part and the body of the megaspore the transition is gradual, both parts are delimited from each other only with a weak lacing. The conical apical part consists of three lobes, opened at the apex. These are named by KEMPF (1971) "Keimöffnungslappen", covering the gula which is smaller-sized than that of Azollae and is here invisible. The megaspores have no floats.

The length of the polar axis is 550–650 μm, that of the transverse axis is 350–400 μm. The height of the conical apical part is 230 μm, the diameter of its basis being 290–300 μm.

There occurred only two specimens in the samples originating from the depth 433.67–433.91 m.

It will have been the megaspore of *Salvinia natans* (L.) ALL.

Salvinia sp. 2 megaspore
(Plate IV, photographs 1–3 and 7)

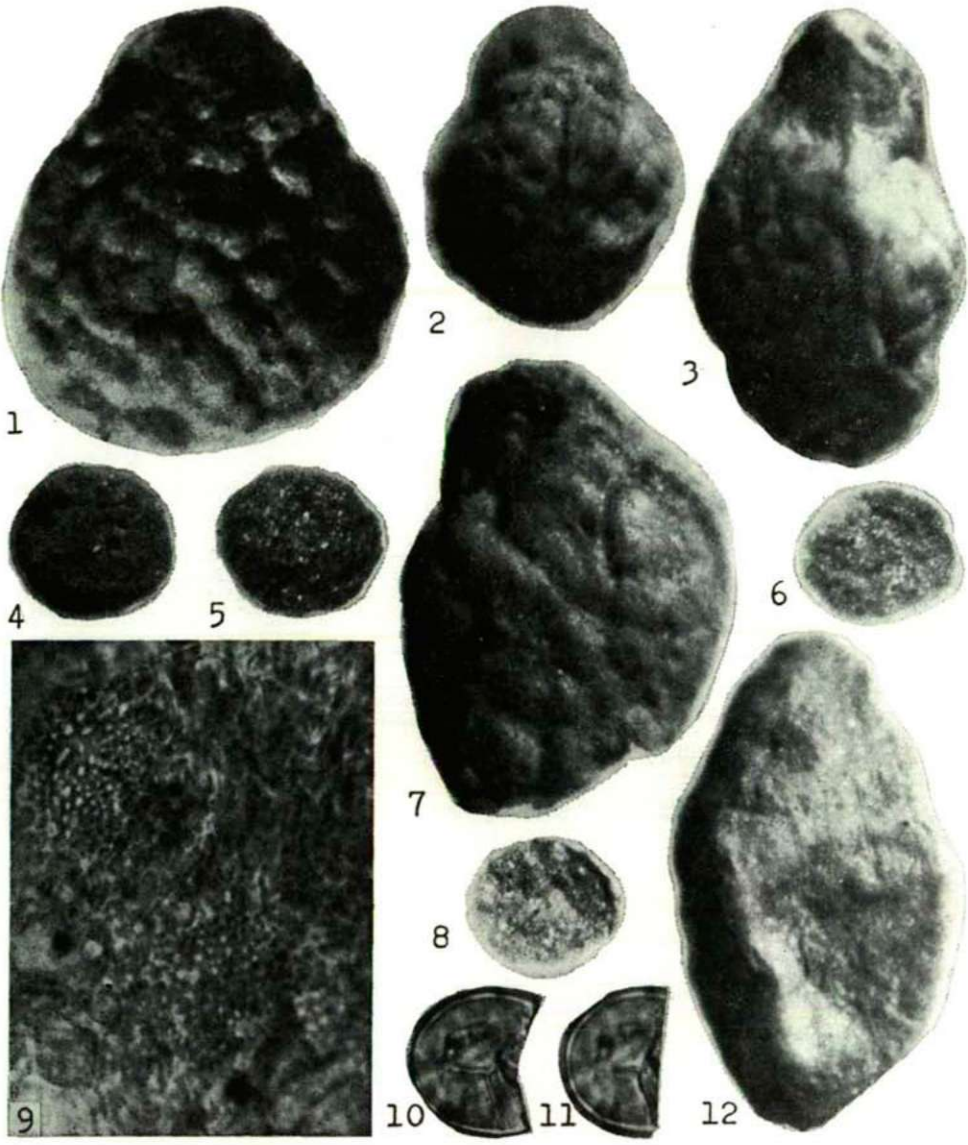
The megaspore is approximately ovoid-shaped, with a body of approximately spherical form to which the conical apical part is attached with a strong lacing.

The spherical or ovoid megaspora body is covered with flat, blurred verrucae. The flat verrucae sometimes resemble to the ornamental elements of *Salvinia cerebrata* NIKITIN ex DOROFEEV (FRIIS, 1977) but they never lie in a polar angle of sight because their longitudinal axis is longer than the transverse axis.

The semicircles of the conical apical part (Keimöffnungslappen) are only a little open, two lobes are generally larger than the third one. The surface ornamentation of these consists of irregular, creased and smaller, verruca-like elements.

The sizes of megaspores are various. The polar axis varies at the measured specimens between 400–650 μm, and the body diameter between 350–550 μm. The verrucae on the body surface have a 50–70 μm basis and are about 10, maximum 20 μm high.

Plate IV



Figs. 1–3, 7: *Salvinia* sp. 2 megapores, x100.
Figs. 4–6, 8: *Salvinia* sp. microsporangia, x100.
Fig. 9: *Azolla danica* surface of the massula, x1000.
Figs. 10–11: *A. danica* microspores, x1000.
Fig. 12: *Salvinia* sp. 1 megaspore, x100.

DOROFEEV (1963a) divides the megaspores into two sections: i.e., the ovoid- and spindle-shaped ones into the *Eusalvinia,* the spherical ones into the Cerebrata section.

The Salvinia sibirica DOROFEEV, published in Kristofovich's book (1957), the *S. intermedia* NIKITIN, published by LAŃCUCKA—ŚRODONIOWA (1958), as well as the S. DOROFEEV megaspores have traits to the *Salvinia* sp. 2 megaspores. Some authors describe, unfortunately, the fossils only with macroscopic methods, without following the precise and manysided elaboration, description and presentation as BUŽEK, KONZALOVÁ & KVAČEK (1971) who have worked also with light microscope, to say nothing of the electron-microscopic *Salvinia* megaspore studies of KEMPF (1971) and FRIIS (1977).

The following stratigraphical Table would give verification and reason for that an unambiguous description and elaboration of *Salvinia* megaspores would be very important.

Table 1: Stratigraphical values of some *Salvinia* megaspores

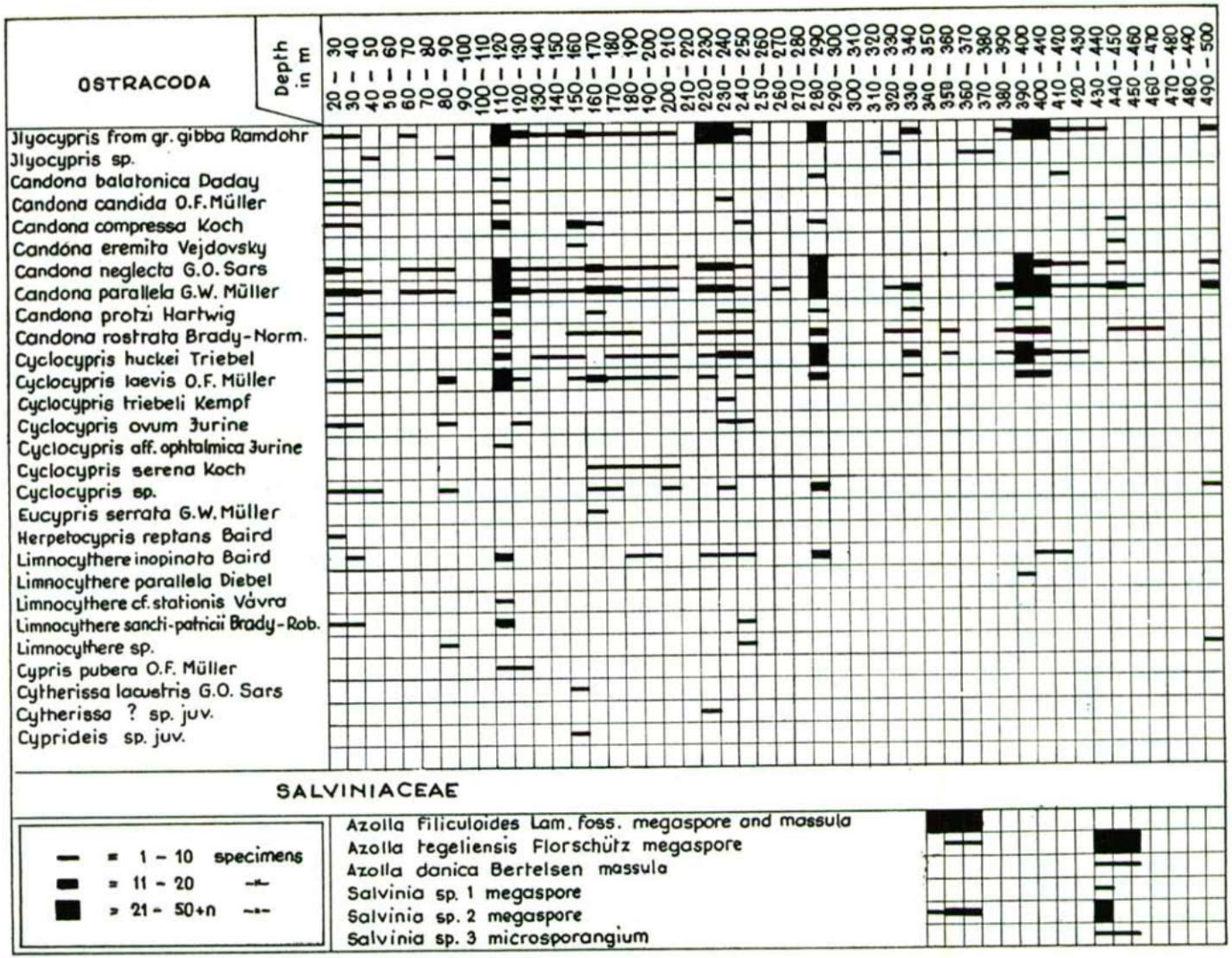
Sectio *EUSALVINIA*	Oligocene	Miocene	Pliocene	Pleistocene
Salvinia sibirica DOROFEEV		+		
Salvinia miocenica DOROFEEV		+		
Salvinia intermedia NIKITIN		+		
Salvinia rhenana KEMPF			+	
Salvinia natans (L.) ALL. foss.				+
Salvinia sp. 1 (SICS. — SZÉLES)				+
Salvinia sp. 2 (SICS. — SZÉLES)				+
Sectio *CEREBRATA*				
Salvinia turgaica DOROFEEV	+			
Salvinia cerebrata NIKITIN ex DOROFEEV	+	+		
Salvinia sp. (FRIIS)		+		
Salvinia glabra NIKITIN			+	
Salvinia maeotica DOROFEEV			+	

Salvinia sp. microsporangium
(Plate IV, photographs 4–6 and 8)

The *Salvinia* microsporangia occur in our preparations in the form of flat disks. Their edge is here and there dentate (Plate IV, photographs 5, 8) what relates to the existence of a sporodermis. In unprepared state, the surface of sporangia is granular. The sporangia, cleared with Na-hypochlorite javellization and examined with light microscope show a vacuolar structure similar to the *Azolla* massulae. In them, the microspores are of 18 μm diameter, with smooth exine and short laesurae of the trilete-mark. Having macerated the micosporangia, we did not find any glochidia.

As samples, we have preparated 2–8, together 13 microspongia from among samples, originating from 449.88–450.00 m, 449.13–449.88 m, and 433.67–433.91 m depths.

Table 2


OSTRACODA
Depth in m
20 – 30
30 – 40
40 – 50
50 – 60
60 – 70
70 – 80
80 – 90
90 – 100
100 – 110
110 – 120
120 – 130
130 – 140
140 – 150
150 – 160
160 – 170
170 – 180
180 – 190
190 – 200
200 – 210
210 – 220
220 – 230
230 – 240
240 – 250
250 – 260
260 – 270
270 – 280
280 – 290
290 – 300
300 – 310
310 – 320
320 – 330
330 – 340
340 – 350
350 – 360
360 – 370
370 – 380
380 – 390
390 – 400
400 – 410
410 – 420
420 – 430
430 – 440
440 – 450
450 – 460
460 – 470
470 – 480
480 – 490
490 – 500
Ilyocypris from gr. gibba Ramdohr
Ilyocypris sp.
Candona balatonica Daday
Candona candida O.F. Müller
Candona compressa Koch
Candona eremita Vejdovsky
Candona neglecta G.O. Sars
Candona parallela G.W. Müller
Candona protzi Hartwig
Candona rostrata Brady-Norm.
Cyclocypris huckei Triebel
Cyclocypris laevis O.F. Müller
Cyclocypris triebeli Kempf
Cyclocypris ovum Jurine
Cyclocypris aff. ophtalmica Jurine
Cyclocypris serena Koch
Cyclocypris sp.
Eucypris serrata G.W. Müller
Herpetocypris reptans Baird
Limnocythere inopinata Baird
Limnocythere parallela Diebel
Limnocythere cf. stationis Vávra
Limnocythere sancti-patricii Brady-Rob.
Limnocythere sp.
Cypris pubera O.F. Müller
Cytherissa lacustris G.O. Sars
Cytherissa ? sp. juv.
Cyprideis sp. juv.
SALVINIACEAE
— = 1 – 10 specimens
= 11 – 20
= 21 – 50+n
Azolla Filiculoides Lam. foss. megaspore and massula
Azolla tegeliensis Florschütz megaspore
Azolla danica Bertelsen massula
Salvinia sp. 1 megaspore
Salvinia sp. 2 megaspore
Salvinia sp. 3 microsporangium

Discussion of results

The fossils raise several problems to be debated. Due to the limited size of this paper, the following can only be discussed in outlines.

1. The phylogeny of Salviniaceae is followed by the papers of HALL (1969, 1974), JAIN & HALL (1969), as well as of JAIN (1971) from the Lower Cretaceous. On the basis of megaspores, the *Azolla* genus appeared in the Campanian and the *Salvinia* in the Maestrichtian and diffused in the Tertiary. The genera occur both in Eurasia and in the American continent. In their diffusion, important changes were induced by the geological recent past, as well, for as much as the *Salvinia* genus died off in North America from the Miocene (MÄGDEFRAU, 1971) and the *Azolla* genus with the *A. filiculoides* in Europa owing to the Saalian glaciation (BERTELSEN, 1972).

By the disappearance of the two genera from large areas their sensitivity to the climatic factors is verified, too. By this fact their palaeographical appreciability and stratigraphical value are considerably increased.

2. The environment of the heterosporous ferns is: the standing or slowly flowing water, lake, inland waters, flood plain, the shallow water left behind after floods and the marsh with open water surface. Fresh waters like these occurred abundantly not only in the Pleistocene but also in the Tisza valley and in the region of the Triple Körös in the time before the river control in the 19th century. In these areas, *Salvinia natans* can be found even today. In this country — according to the floristic researches of VINCE BORBÁS — among the first discovered habitats takes place Vésztő and e.g. LUERSEN (1889) publishes this place of discovery with the following orthography: "Galfizug nächst Veszto im Comitate Bekes (BORBÁS, in Linnaea 45, pag. 216)". May the ducks have enjoyed already in the Lower Pleistocene the ancestor of the present-day Salviniae in the marshes of Kis-Sárrét? (The Hungarian name of *S. natans* is namely "duck-pleasure").

3. According to the results received hitherto, in our material Azollae and Salviniae occur together. They may have lived together, creating freshwater associations, so-called communities of plants floating, on the water surface or like the constituents of these (SOÓ, 1964). For the time being, the other members of the community are not known but a palynological investigation to-be may discover the autochthonous species or genera that had lived in the marshes and give a picture of the environment, the environmental vegetation of the surrounding Lower Pleistocene marshes.

4. Our fossils — as mentioned in the Introduction — came to light as by-products of the investigations of MARGIT SZÉLES into Ostracoda. The 500 m thick Pleistocene can hardly be divided on the basis of the Ostracoda fauna although it is to be supposed that very variegated events had passed off climatically during the sedimentary process. The researcher of Ostracoda nonetheless separates about three phases (Table 2):

From 520 m till ca 320 m few species occur but some of them with high enough frequency (e.g., *Cyclocypris huckei*), whereas the *Limnocythere, Cypris, Cytherissa* species are lacking therin almost entirely.

From 29 m till 110 m the fauna may perhaps be considered as the richest one. Opposite to the low level, the presence of several *Limnocythere* species and numerous *Cyclocypris* species is characteristic.

Above 100 m, many kinds of the *Candona* species, at 22 m the huge *Herpetocypris* and generally the decrease of the fauna are characteristic.

This modest division which cannot be detailed and accounted for here, is variegated by Ostracoda-free phases.

5. Our Salviniae and Azollae are given in Table 2, presenting the Ostracoda fauna. Evaluating these, the following issues can be raised:

(a) It is true in Vésztő, as well, what in the frontier zones of Denmark-Holland-Belgium-Germany proved true, namely that *Azolla tegeliensis* is older than *A. filiculoides*.

(b) It is probable that the first appearance of *A. filiculoides* at Vésztő is the 360–370 m deep Pleistocene sediment.

(c) The area of *A. tegeliensis* grew wider with the occurrence at Vésztő and, therefore, it is not limited to the above-mentioned countries.

(d) *Azolla filiculoides* and *A. tegeliensis* must have been on Hungarian territory, as well, the flora-creator and indicator of the climate, corresponding to those of the interglacial periods.

(e) The two *Azolla* species can have in Hungary, facing south, another stratigraphical value, as well, than in the countries lying along the North Sea.

(f) By means of the Ostracoda fauna, the lower section of the first boring at Vésztő (520–320 m) can be considered as undivided. But on the basis of *Azolla* megaspores, it can clearly be divided (with a 60 m gap) into a lower section with the dominance of *A. tegeliensis* (450–430 m) and into an upper section with the dominance of *A. filiculoides* (370–340 m).

6. The Pleistocene *Azolla* (and *Salvinia*) megaspores can easily be determined macroscopically with a "Cytoplast" (Zeiss) binocular stereomicroscope from the washed sample without any special treatment. Because of their facies-marking and stratigraphical importance, the research into these megaspores from the Pleistocene of the Great Hungarian Plain is justified, parallel with the Ostracoda, Mollusca, Diatoma investigations.

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EFFECT OF THE INTENSITY OF ILLUMINATION ON THE DRY-MATTER PRODUCTION AND TISSUE STRUCTURE OF THE CAPSICUM SPECIES

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Abstract

Six different Capsicum species have been investigated in a phytotron to determine dry-matter production and the tissue structure of stem and leaf as a function of light intensity. Light energy was varied between $1.0.10^4$—$4.5.10^4$ erg cm^{-2} sec^{-1}. It was established that:

1. The light demand of different species varies considerably, but there is no close connection between light demand and dry-matter production.
2. In general, leaf area changes with the intensity of illumination according to an asymmetric optimum-curve.
3. There is a significant positive correlation between the intensity of illumination and stoma number, as well as between the leaf cross-section and the epidermial cell count.
4. Dry-matter production shows a close positive correlation to the thickness of leaf-blade, the amount of spongy parenchyma and the xylem part of the vascular tissues of the stem.
5. From among the tissue areas of the stem, there is a significant negative correlation between the xylem part and the pith parenchyma.

Introduction

One of the important fields of interest of botanical research is the understanding of the many factors involved in the growth and development of plants. Among the environmental factors affecting this, light is of primary importance, being the energy supply for plant photosynthesis. The effect of light on tissue structure finds an expression through the external morphological properties of the plant. Tissue structure and morphology are often directly related to the production of organic matter.

In our experiments, we have dealt with the effects of different intensities of illumination on the morphological properties, the changes in the tissue structure of the stem and leaf, as well as the dry-matter production, of six Capsicum species.

Literary survey

Photosynthesis is considerably affected by several anatomical properties of plants, including the thickness of leaves, the structure of the assimilating parenchyma, and also by the proportion of vascular tissues. The relationship between tissue properties and organic production is not yet unambiguously established. The role of the spongy and palisade parenchymas in photosynthesis is particularly controversial. The same applies to the connection between morphological characteristics and the quantity of the photosynthetically produced dry matter.

BALLATTINE and FORDE (1970) investigated the tissue structure of the leaf of the soybean as a function of the intensity of illumination. A change was found in the structure of the spongy parenchyma: as a result of a greater light intensity the spongy parenchyma is more developed, showing an increase of 8 to 10 percent.

DARMANADEN et al. (1974) studied the connection between photosynthesis and the palisade and spongy parenchymas in the leaves of lettuce. These authors established that, in the spongy parenchyma, photosynthesis is more intensive and plastids differentiate, more quickly. Similarly, OUTLOW et al. (1976), measured the activity of some enzymes of CO_2 fixation in extracts of palisade and spongy parenchyma cells from the leaves of *Vicia faba*. In the cells of the spongy parenchyma enzyme activity is higher. Thus it may be concluded that, under identical conditions of illumination, CO_2 incorporation is greater in spongy parenchyma than in the palisade tissue. Opinions vary, however, in respect of the parts played by the spongy and palisade parenchymas in photosynthesis. One cause of this debate may be that the assimilating tissue functions in different ways, under different intensities of illumination. Such a result is known from OUTLOW's and FISCHER's investigations (1975) with *Vicia faba*. By increasing light intensity, photosynthesis increased in the palisade parenchyma, while in the spongy parenchyma it did not change.

NOBEL (1976) investigated the morphological and tissue characteristics of light and shade leaves. On increasing the intensity of illumination, the leaf-size decreased, leaf thickness increased and the palisade and spongy parenchymas were more developed. The greater photosynthetic activity was probably due, primarly, to the large inner surface of the leaf.

FRETZ and DUNHEM (1972) studies the connection between the intensity of illumination and the tissue structure of the leaves of *Ilex* species. Leaf area, leaf-blade thickness, and parenchymas all differed significantly as a function of illumination intensity, taken as a function of the intensity of illumination, generally changes according to an optimum-curve (BEAN, 1964).

Apart from the structure of mesophyll, stomatousness can also be connected with dry-matter production. Of all the tissue characteristics of the leaf, this factor responds to light most markedly.

KNECHT and O'LEARY (1972) ascertained that, under controlled conditions, at the epidermis of bean leaf, stoma-frequency significantly increased, as a function of intensity illumination. GAY and HURD (1975) obtained a similar result for tomatoes. Stoma-formation was retarded by a decrease in the intensity of illumination. The same phenomenon was observed by RAWSON and CRAVEN (1975) with tobacco and sunflower species.

HEICHEL (1971) called the attention to the connection between stoma-number and photosyntetic production of organic-matter. He established that in maize, photosynthesis is more intensive in leaves where the stoma-frequency is less.

FEKETE and SZUJKÓ—LACZA (1973) also found significant differences in the anatomical structure of leaves of *Quercus pubescens*, grown in four habitats of diverse water- and light supply. (Stoma-frequency, palisade and spongy parenchymas, rate of assimilating tissues and intercellular spaces). They have ascertained that the intensity of photosynthesis is altered according to the ratio of assimilating tissue to intercellular spaces and not by the stoma frequency. Light conditions also affect the vascular tissue system and, through this, the organic-matter production.

The activity of the cambium is increased by the increase in the intensity of illumination and, as a result of this, a more developed vascular tissue is formed (LEMAN) 1955, JANKOVICH 1956, HORVÁTH 1965, SIMONNÉ—WOLCSÁNSZKY, SZEGEDI 1969, DENNE 1974).

Materials and Methods

The investigations were performed in the phytotron of the Botanical Gardens of the Attila József University (HORVÁTH 1972). Test plants were: 6 species of *Capsicum annuum*, namely: Javított cecei (Improved one from Cece), Magyar fűszer (Hungarian condiment), Cseresznye alakú (Cherry-spaped), Keszthelyi fehér (White from Keszthely), Szentesi fehér (White from Szentes), Paradicsom alakú zöld (Tomato-shaped green) hungarian sorts. The experiment was repeated twice. The plants were grown in sand cultures and nutritive solution "KNOP" was used. The 70 percent water capacity was set on at the setting of the experiment, departing from air dry sand with nutritive solution. The permanent water content of the sand culture was preserved by watering it daily with distilled water on a weight basis. Once weekly, the plants were given an identical quantity of nutrient solution.

The daily temperature variation was between 20—25 °C. Air vapour content varied between 50—70%.

Illumination was provided by F_{20}-type fluorescent lamps of 40 watt (12 hours light, 12 hours dark). Different intensities of illumination were obtained by placing layers of tracing paper in front of the flvorescent tubes. The paper did not alter the spectral distribution of light energy. The following light treatments were applied:

$4.5.10^4$ erg cm^{-2} sec^{-1}	ca.	10.000 lux
$3.5.10^4$ erg cm^{-2} sec^{-1}	ca.	7.700 lux
7.10^4 erg cm^{-2} sec^{-1}	ca.	4.400 lux
$1.5.10^4$ erg cm^{-2} sec^{-1}	ca.	3.300 lux
$1.0.10^4$ erg cm^{-2} sec^{-1}	ca.	2.200 lux

In the following pages these light treatments are given with a coefficient of 10^4 erg cm^{-2} sec^{-1}.

The plants were processed at an age of 8 weeks. After being fixed at 105 °C, the dry weight was determined for each organ, by heating at 70 °C to constant weight.

For examination of organ structure, leaves were taken from node 3 and stems from internodium 4, from each of ten plants. For examination, preparations were made from the middle third of the leaf-blade.

The collected material was fixed in a mixture of ethylalcohol-formalin-distilled water, in the ratio of 3:1:1.

Epidermis was prepared by maceration, cleaned, stained with Ehrlich's acid haematoxylin, dehydrated, and then stabilized with Canada balsam.

For cross-sectioning, leaf and stem tissues were embedded in celloidin, and cutting with Reichert's slide microtome.

For studies on the epidermis, the epidermis cell, and stoma-numbers per unit area were determined for both epidermises. (As preparation from the average of 50 fields sight each).

From the leaf cross-section, leaf-blade thickness, the ratio of spongy to palisade prenchymas, and the size of cells were determined. From the cross-section of the stem, the ratio of the following tissue regions were determined: primary bark, xylem part, phloem part, mechanical tissue, pith parenchyma. The ratio of tissue regions was determined of the basis of the area of details drawn by means of a lanometer.

The examined tissue properties were analysed with t-test and correlation analysis (SVÁB, 1973).

Results and Discussion

(a) Dry-matter production

Plants grown at low intensity of illumination (2200–3300 lux) had 8–10 leaves. Those grown at 7,700–10,000 lux had 12–12 leaves. No buds were visible.

Dry weights are summarized in Table 1.

Table 1

mg/plant

Species	light energy (10^4 erg cm^{-2} sec^{-1})				
	4.5	3.5	2.0	1.5	1.0
White of Szentes	609	626	441	308	154
Tomato-shaped	586	691	418	302	183
White of Keszthely	512	563	372	302	194
Improved from Cece	817	643	551	346	277
Hungarian condiment	498	492	457	436	346
Cherry-shaped	439	457	410	382	322

It is immediately apparent that dry-matter production and light demand of individual species are considerably different. There is no obvious connection between light demand and the dry-matter production: the dry matter of the least light-demanding capsicum species, the tomato—shaped one, is the third in sequence. The most light-demanding species is the improved one from Cece.

The light-curves reflecting the light demand are shown in Fig. 1.

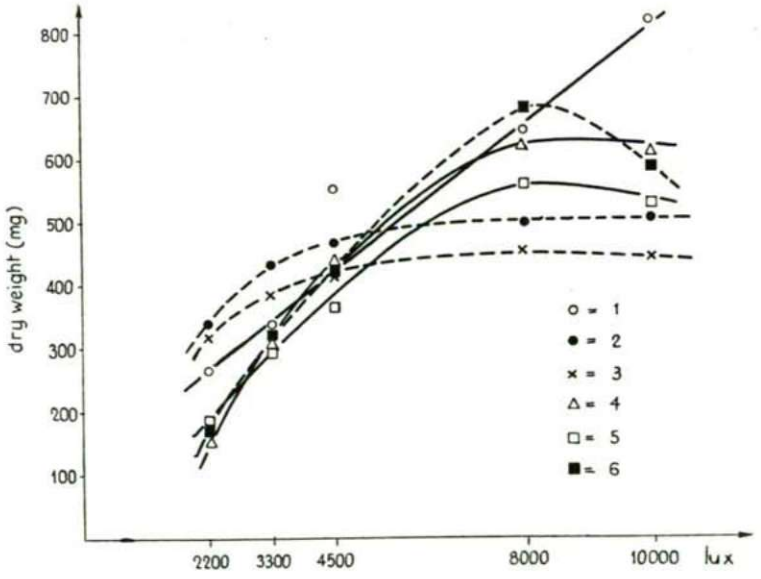


Fig. 1. Dry weight of capsicum species, as a function of the intensity of illumination (light-curves).

It can also be shown that in general the more light-demanding a species is, the larger is the weight difference as a function of the intensity of illumination. Similar results are mentioned by BAROOVA—HORVÁTH (1973) and BERNÁTH (1976).

From among the morphological properties, we shall only discuss leaf area, beacause this factor is generally most closely related to dry-matter production.

Variation in leaf area for each species was considerable being more than 100

percent. (The largest and smallest leaf areas calculated for one plant are 512 and 252 sq. cm, respectively). There was no direct proportionality between light-demand and leaf-area.

In general, leaf are changed together with the intensity of illumination, according to an asymmetrical optimum-curve. With two species, under our experimental conditions, leaf area was practically unchanged, as a function of the intensity of illumination. The Cherry-shaped species gave the most marked response: the difference between the smallest and largest leaf areas being five-fold (Fig. 2.)

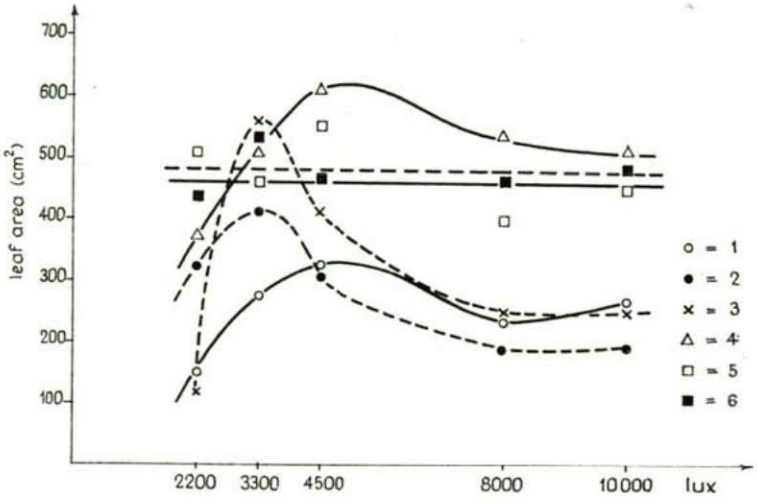


Fig. 2. The average leaf area of Capsicum species calculated to one plant, as a function of the intensity of illumination.

Our data also show, that maximum leaf area was formed at about 3–4,000 lux, and did not change with light intensities up to 8–10,000 lux. This result was obtained with all the species tested.

Our results are in agreement with the earlier results of HORVÁTH (1965), as well with those of COOPER and TAINTON (1968) and BERNÁTH (1976), according to which, leaf area is increased within limits by lower light energy levels.

These results also support Bean's statement (1964), that leaf area generally changes as a function of illumination intensity according to an optimum-curve. The percentage of the total dry weight represented by the leaf is larger with species of higher light-demand (KUDRYAVSTEV, 1964; MC. WORTHER-JORDAN, 1976). Among different Capsicum species the fraction of the dry weight represented by the leaf may vary by some 10–20 percent.

The result of our histological investigation (Plates 1, 2, 3) are summarized below that, in general we were analysing the correlation between the tissue properties the intensity of illumination, and the dry-matter production.

The epidermial cell count per unit area increased, particularly on the lower epidermis, in parallel with the intensity of illumination. The connection is strong, the correlation coefficient is also significant at level $r = +0.96$ and p 5 percent (Fig. 3).

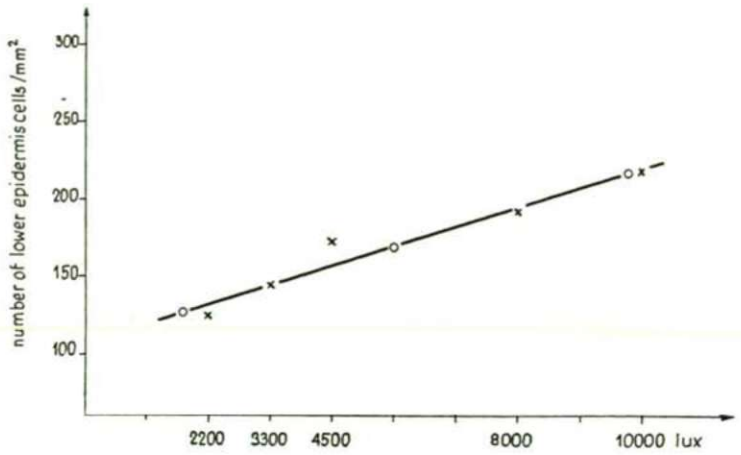


Fig. 3. Connection between the cell count of the lower epidermis (piece/sq. mm) and light energy-on the basis of the mean values of the 6 capsicum species.

The difference of cell counts between the two extreme intensities of illumination is significant even at level p 1 percent.

The leaf of Capsicum is amphistomatic; the number of stomata is some 5–6 times lower at the upper surface, than at the lower epidermis. The formation of stomata was, however, considerably inhibited, particularly on the upper epidermis, by a decrease in the intensity of illumination. Under such conditions the leaf became almost hypostomatic. (1 piece) sq.mm stoma contra 10–35 piece (sq.mm). A similar tendency may be observed at the lower epidermis (Fig. 4).

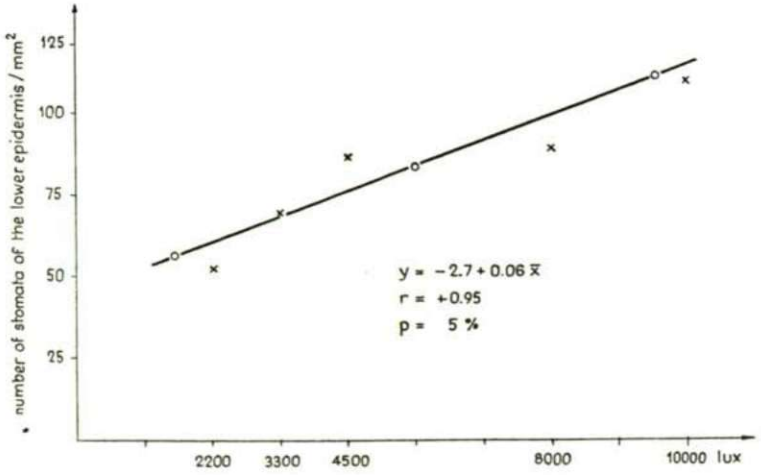
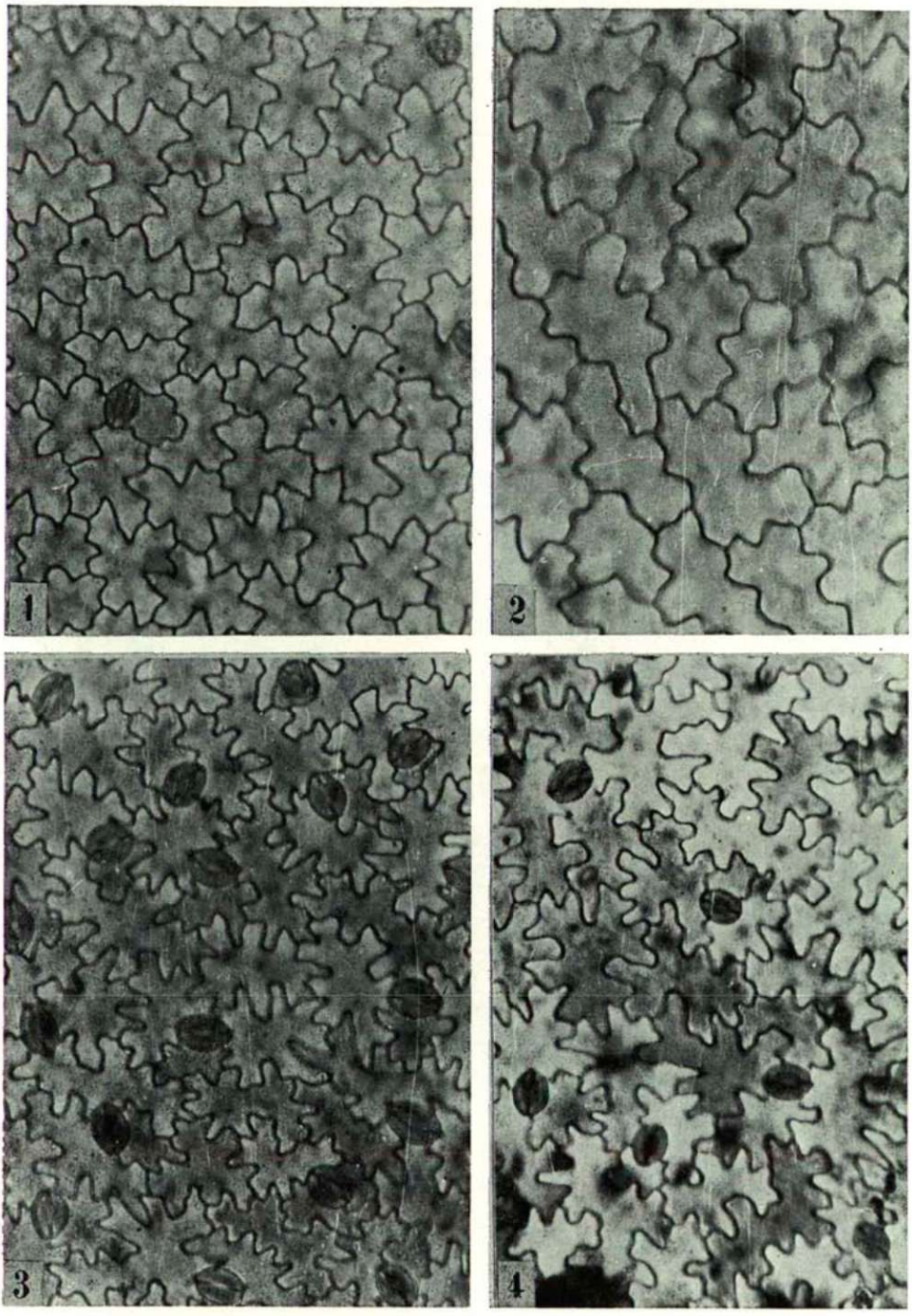


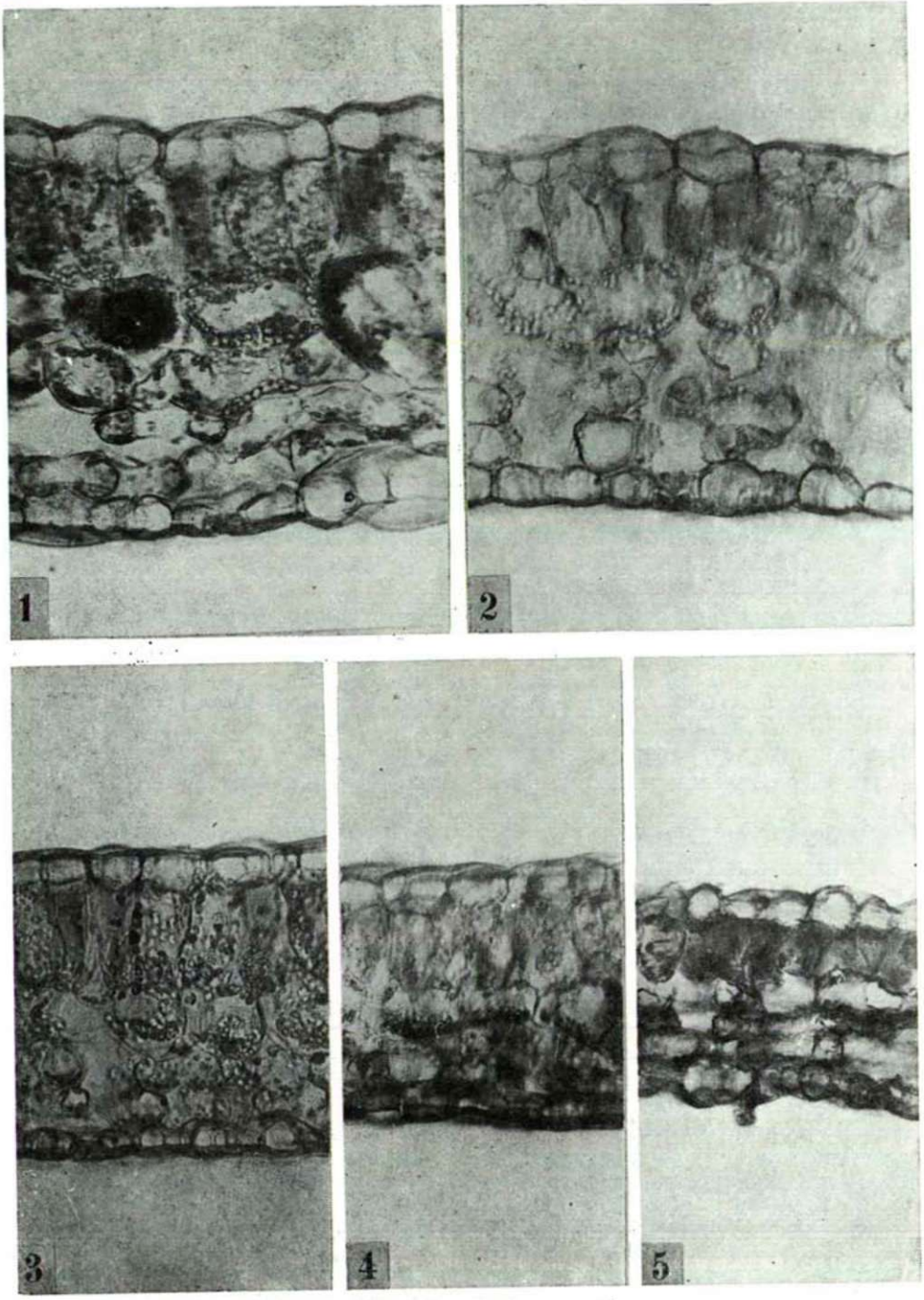
Fig. 4. Connection between the stoma number of the lower epidermis (piece/sq. mm) and light energy, on the basis of of the mean values of 6 Capsicum species.

Plate I



Capsicum annuum L. c. v. White of Keszthely
1. upper epidermis 10.000 lux (250 x).
2. upper epidermis 2.000 lux (250 x).
3. lowet epidermis 10.000 lux (250 x).
4. lower epidermis 2.000 ux (250 x).

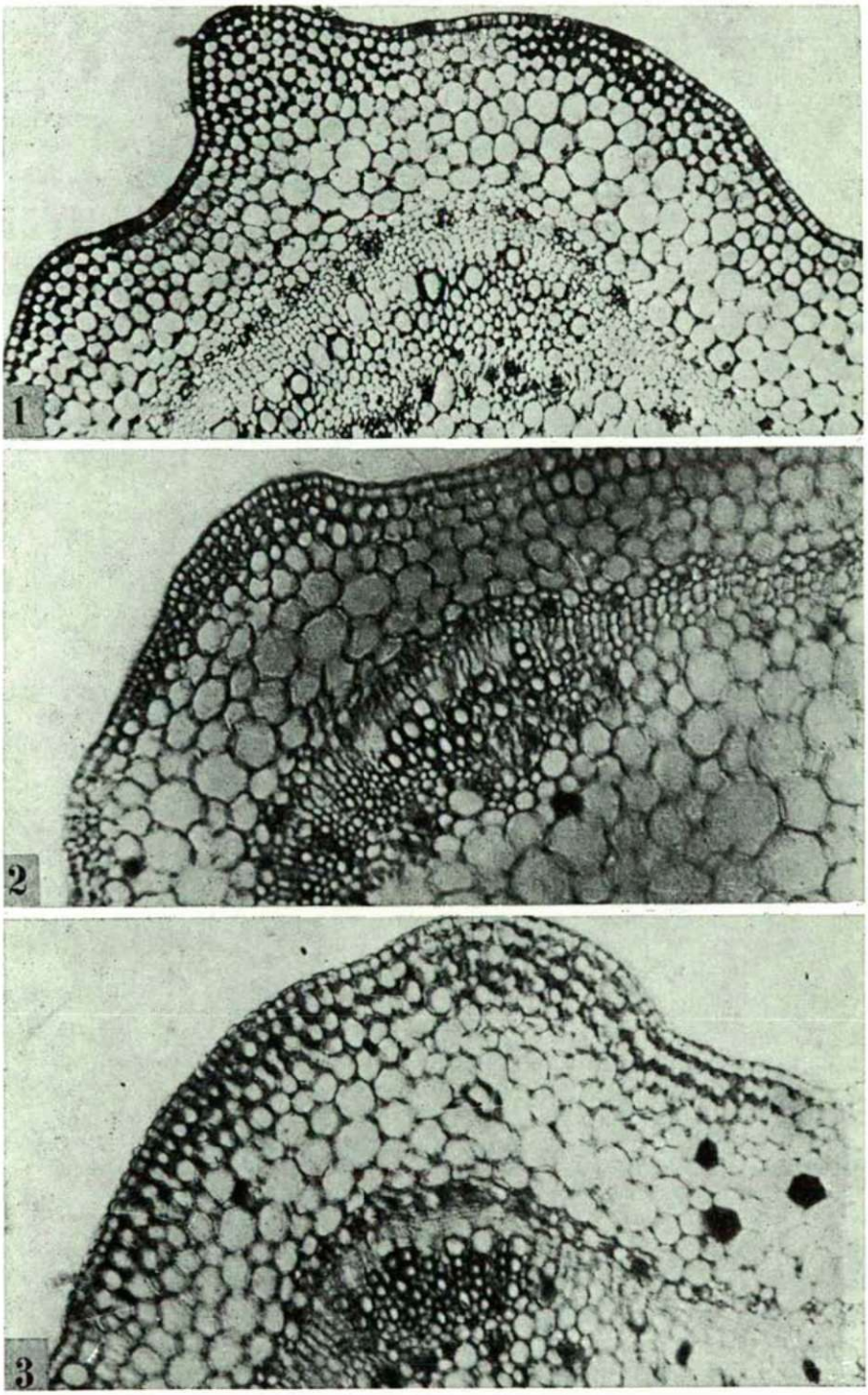
Plate II



Capsicum annuum L. c. v. Improved from Cece, leaf cross section

1. 10.000 lux (250 x).
2. 8.000 lux (250 x).
3. 4.500 lux (250 x).
4. 3.000 lux (250 x).
5. 2.000 lux (250 x).

Plate III



Capsicum annuum L. c. v. Tomato shaped green. stem cross section.
1. 10.000 lux (85 x) 2. 8.000 lux (85 x) 3. 3.000 lux (85 x).

There was no significant correlation between stoma number per unit area and dry weight.

According to FRANK (1969) and HEICHEL (1971), the stoma frequency decreases in parallel with the increase in the photosynthetic productivity. From our investigations, the connection is not close. We agree, however, with FEKETE and SZUJKÓ (1973), that dry-matter production is modulated, in some way, only by the intercellular spaces. NOBEL (1976) emphasizes that greater photosynthetic activity is induced by a larger inner surface of the leaf.

The correlated, parallel changes between the thickness of the leaf-blade and the intensity of light are generally known. The correlation is close, according to our investigations. It is significant at $r = +0.94$ and at 5 percent level (Fig. 5).

The improved species from Cece was most sensitive to changes in light intensity, the extremes of leaf thickness differed by 100%. The thickness of the leaf of less light -demanding species changed to a lesser extent.

There is a close correlation between thickness of the leaf-blade and dry weight. The value of r is +0.96 and the connection is significant at p 1 percent level (Fig. 6).

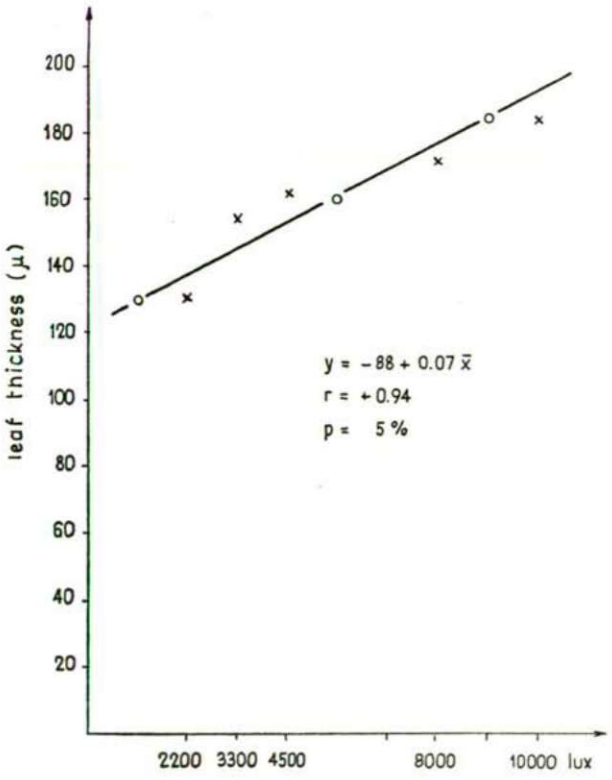


Fig. 5. Connection between the thickness of leaf-blade and light energy, on the basis of the mean values of the six Capsicum species.

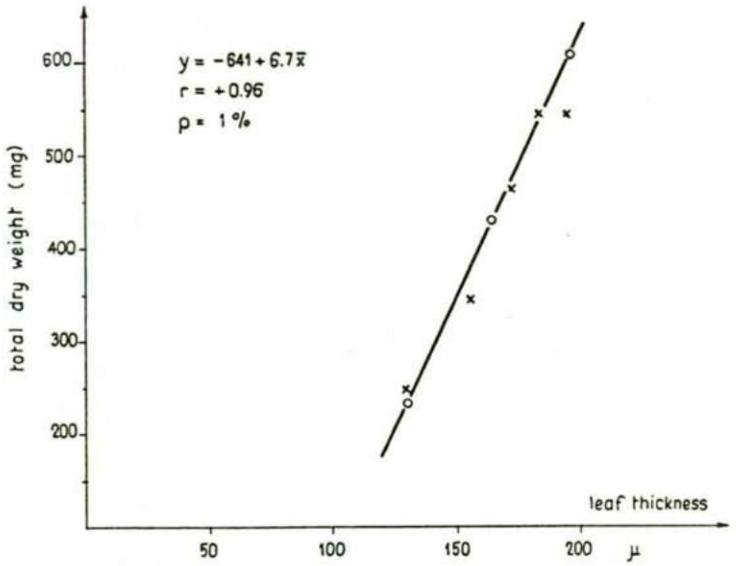


Fig. 6. Connection between the dry weight and the thickness of the leaf-blade, on the basis of the mean values of the six capsicum species.

The effect of the intensity of illumination on the assimilating parenchyma is considerable, too. This effect appears in the spongy parenchyma. The amount of the spongy parenchyma increases as a function of the intensity of illumination. The connection is close, it is significant at the level of $r = +0.98$ and p 1 percent (Fig. 7).

We remark that the extreme values appearing in the development of the spongy parenchyma significantly differ from one another at the level $p = 0.1$ percent, as well. The parts played by the spongy and palisade parenchymas in photosynthesis is often debated. According to our data, in the case of Capsicum, the increased photosynthetic role of the spongy prenchyma is proved by the increased production of organic matter. Similar conclusions are also drawn by a number of other research workers, e.g., STARZECKI, 1962; BALLANTINE—FORDE, 1970; DARMANADEN et al., 1970; OUTLOW et al., 1976.

From among the tissues of the stem, the development, of mechanical tissues bears a close positive correlation with intensity of illumination. The difference between the extreme values is significant at p 0.1 percent level. The percentage of mechanical tissues varied in our investigations between 6 and 10 percent. The most striking phenomenon is the different development of the xylem part of vascular tissues. This shows a close positive correlation with the intensity of illumination and is significant at $r = +0.90$ and at p 5 percent level. Even more striking is the connection between the development of xylem tissue and the dry matter. Again, this a positive correlation and significant at p 0.1 percent level (Fig. 8).

In the phloem part of vascular tissues the difference is much less pronunced and is only significant between the two extreme intensities of illumination $p = 5$ percent.

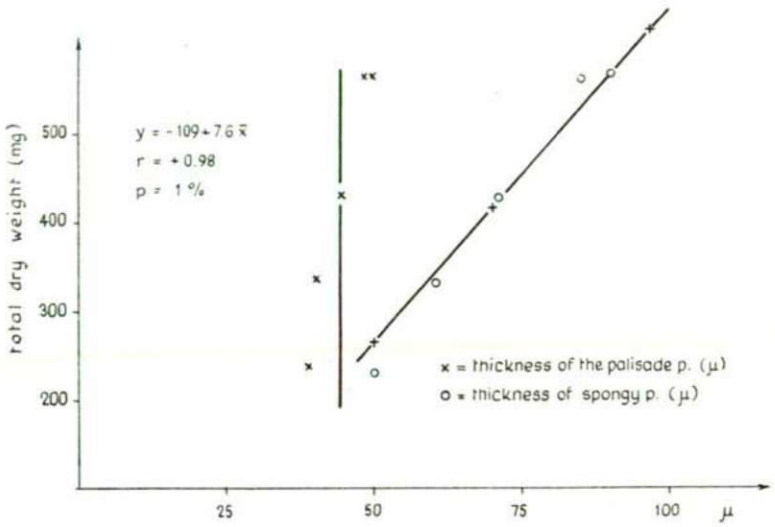


Fig. 7. Connection between the total dry weight and the thickness of the spongy, resp. palisade parenchyma, on the basis of the six *Capsicum* species
x = thickness of the palisade parenchyma
o = thickness of the spongy parenchyma.

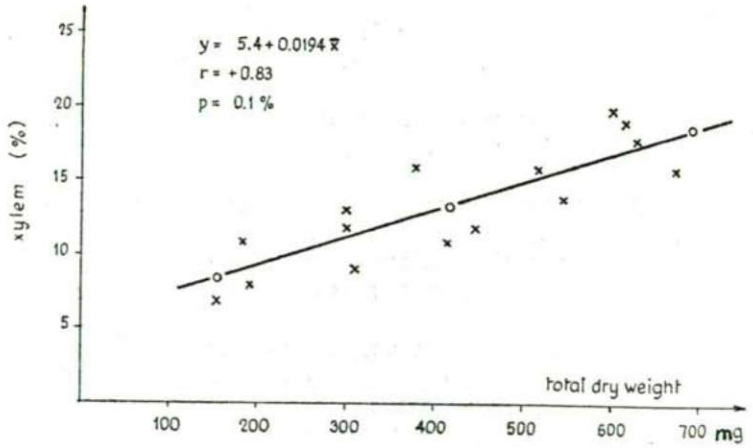


Fig. 8. Connection between the total dry weight and the percentage of the xylem part (stem), on the basis of the Tomato-shaped, White from Keszthely and White from Szentes capsicum species.

Of tissue areas of the stem the pith parenchyma changes considerably. This decreases, as a function of the intensity of illumination, significantly at $r = -0.92$ and p 5 percent.

The change in the tissue area is, therefore, contrary to the change in the xylem part of the vascular tissue and the reliability of the connection is significant at p 1 percent level (Fig. 9).

We have earlier indicated such a connection (HORVÁTH, 1965) and a number of similar results have been reported (LEMAN, 1955; JANKOVICH, 1956; Mrs. SIMON and SZEGEDI, 1960; GULYÁS et al., 1970; TAKÁCS, 1973).

In Tables 1–3. the changes induced in the epidermis, the tissue structure of he leaf, and the stem are demonstrated.

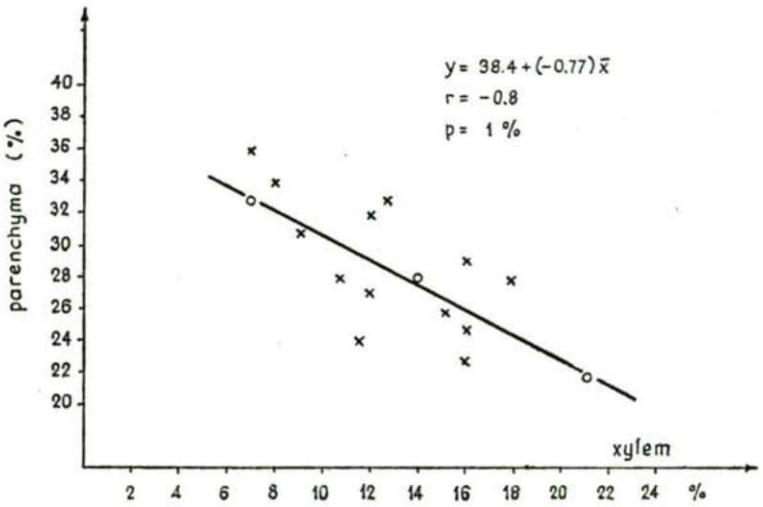


Fig. 9. Connection between the percentage of pith parenchyma and xylem part, on the basis of. the Tomato-shaped, White from Keszthely and White from Szentes species.

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HORMONE CONTENT AND HORMONE METABOLISM STUDIES IN MALE-STERILE SUNFLOWER

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Abstract

100% male-sterility may be induced in sunflower by 0.03 ppm GA_3 treatment at an appropriate time. By means of analysis of the hormone contents (IAA, gibberellin) of the treated inflorescences, it may be established that the maximum extent of male-sterility is not directly connected with a high endogenous concentration of gibberellin. In the most effective treatments (III, IV), the metabolization of IAA is very fast, but it is probable that that of GA_3 is also faster than in samples I and II, treated in a less developed state, in which the male-sterility percentage is low. This is supported by the high IAA oxidase activity in the male-sterile flowers compared to the control. It may be concluded from the results that the high GA_3/IAA ratio developing shortly after the treatment forms the hormonal base of the male-sterility. This is also suggested by the experience that the development of gibberellin-induced male-sterility can be partially inhibited by post-treatment with auxins.

Introduction

The influencing of the sex of flowers by exogenous hormones is an interesting procedure from both theoretical and practical aspects. One of the fundamental problems of hybrid breeding, for example, is the production of a male-sterile flower or inflorescence, a suitable method for wich may be treatment with certain hormones. Hormone treatment for such purposes was first applied to sunflower by SCHUSTER (1961, 1963, 1969).

In an earlier paper (FRANK et al., 1977) we reported experiments in which attempts were made to induce male-sterility in sunflower inflorescence by auxin and gibberellin treatment. In these experiments we also studied the changes in the gibberellin and auxin contents following treatment (KÖVES et al., 1978).

The subject of our present work was the study of the connection between the intensity of the hormone metabolism and the gibberellin-induced male-sterility.

Materials and Methods

In the outdoor experiments the shoot apices of 33, 35, 37 and 39-day-old plants of the species Helianthus annuus WNIIMK 6540 were treated with 0.033%, 0.016% and 0.0033% aqueous solutions of GA_3 (a product of Phylaxia). The method used for the treatment was uptake of the solutions via pipette. The sample included the tip bud and the uppermost leaf circle surrounding this (Fig. 1).

After every treatment, a sample was taken on the third day. Samples taken at four consecutive times were designated samples I–IV. Sampling was performed on the following days: 13 June 1975, 15 June 1975, 17 June 1975 and 19 June 1975 I–IV, respectively.

After paper-chromatographic separation, the amount of IAA (indole-3-acetic-acid) was determined by the method of HANCOCK and BARLOW (1952) and BENTLEY and HOUSLEY (1954) on the basis of the growth reaction of Avena coleoptile segments.

Gibberellin was determined on a methanolic extract by means of the barley endosperm test (JONES and WARNER, 1967) after ethyl acetate fractionation and layer-chromatographic separation (REINHARD et. al., 1964).

IAA oxidase activity was determined by colorimetric method of GALSTON and DALBERG (1954). Other conditions and procedures connected with the outdoor experiments were described previously (FRANK et al., 1977).

Fig. 1. Sunflower shoot apex used for sampling.

Results and discussion

A detailed account was given earlier (FRANK et al., 1977) of experimental results indicating that total male-sterility can be induced in sunflower by 0,033% GA_3 treatment (Fig. 4). Analysis of the auxin and gibberellin contents of the treated and untreated shoot apices led to the following results.

The endogenous IAA content of the control shoot apices varies with the time of examination according to an optimum curve, the maximum of which appears at the second sampling.

The endogenous gibberellin content displays a uniformly decreasing tendency in the examination period (Fig. 2).

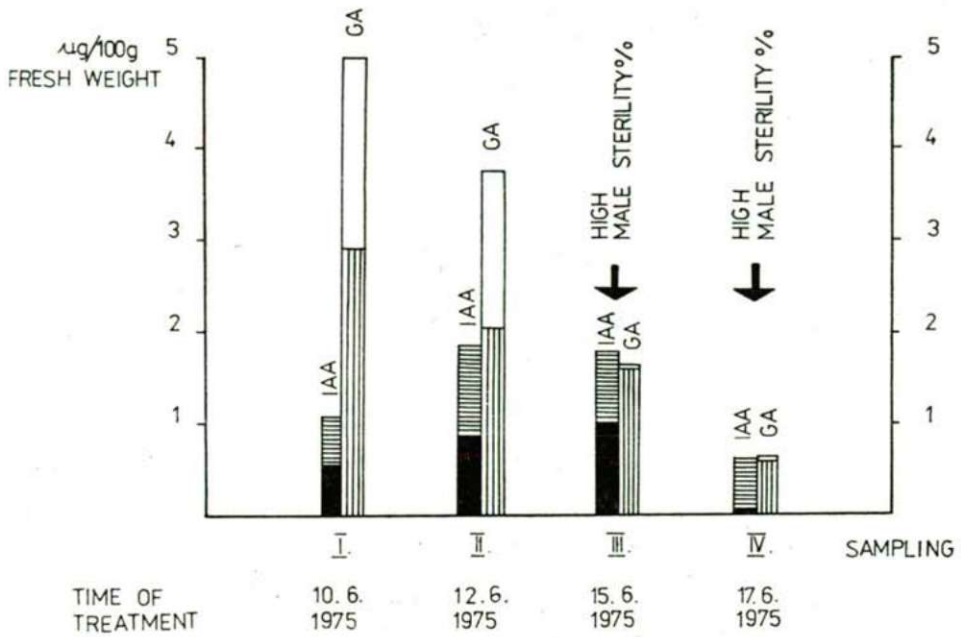

Fig. 2. IAA and gibberellin contents of sunflower shoot apex.
■ IAA content of plant treated with GA_3 (0.033 %),
▤ IAA content of untreated plant,
□ Gibberellin content of plant treated with GA_3 (0,033 %),
▥ Gibberellin content of untreated plant.

The extent of the change in the hormone level resulting from the treatment is decisively influenced by the time of treatment and, in connection with this, by the developmental state of the shoot apex (Fig. 2). The effectivenes of treatment increases progressively during the examination period, and is the greatest at the time of the third treatment and sampling, i.e. in the 37-day-old plants. The extent of the increase in the gibberellin content of the gibberellin-treated plants is the highest at the beginning of the examination period; it gradually decreases, and the highest male-sterility percentage is to be found in the inflorescence formed on the shoot apex with a similar gibberellin content to that of the control. The gibberellin content is also a function of the GA concentration used for treatment (Table 1).

The IAA content generally decreases compared to the control in objects treated with gibberellin. These hormone level variations resulting from the treatment vary the gibberellin/IAA ratio too (Fig. 2 and Table 1).

The most striking feature in the correlation of the male-sterility and the hormone level measured 3 days after treatment is that the extent of male-sterility is not proportional to the endogeneous gibberellin content. The highest gibberellin level observed in the first treatment caused male-sterility to only a slight extent. The high gibberellin level here is explained in that the metabolic activity is moderated in this developmental state, and the gibberellin administered during treatment is metabolized

Table 1. Correlations of the GA_3 concentration used for treatment and the endogenous gibberellin and IAA contents with the extent of male-sterility in sunflower shoot apex.
The Table shows the results obtained in the analysis of samples III. The data are the averages of the results of 3 parallel examinations

Treatment	Treated shoot apex				Total male-sterility*, %
	gibberellin content		IAA content		
	µg/100 g fresh. wt.	% of control	µg/100 g fresh wt.	% of control	
0,03% GA_3	1,6	100	1,06	59	100
0,016% GA_3	6,2	400	1,75	98	75
0,0033% GA_3	8,8	500	1,42	78	12

* The percentage value of the male-sterility refers to the treated plants.

slowly. Similarly, the slow metabolism is also the reason why the endogenous gibberellin level is relatively high at a lower exogenous gibberellin concentration. The intensity of the metabolism is enhanced in the course of the development of the shoot apex, and at the same time the measurable gibberellin content decreases. This is reflected in the phenomenon that the gibberellin content measured on the third day after treatment decreases in the samples taken consecutively every 3 days.

This is also the reason why a direct correlation is not found between the measurable quantity of endogenous gibberellin and the extent of male-sterility, but between the intensity of the gibberellin metabolism and the extent of male-sterility. What has been said refers to the IAA content too, and the IAA metabolism may be of similar importance in the development of the hormonal base of the male-sterility; The extent of this metabolism is probably enhanced by the gibberellin treatment at the concentration employed.

All of the signs indicate that the active IAA metabolism is one of the important factors inducing the male-sterility, presumable by decreasing the IAA level.

When the activity of IAA oxidase was measured in male-sterile sunflower inflorescence, it proved to be substantially higher than the IAA oxidase activity of normal inflorescence. This supports our assumption in connection with the important role of the IAA metabolism, all the more so since the IAA oxidase activity was higher than normal not only in the gibberellin-induced male-sterile inflorescence, but also in the Plasmopara halstedii-induced and the cytoplasmic male-sterile inflorescence (Table 2).

Table 2. IAA oxidase activities of cell-free extracts of male-sterile and normal sunflower tubular flowers

Sample	Decomposed IAA µg/g fresh weight/ hour
1. Control	43,0
2. Male-sterile induced with GA_3	333,3
3. Male-sterile infected with Plasmopara	250,0
4. Cytoplasmic male-sterile	200,0

The available data are not yet sufficient for a coherent picture to be obtained of the hormone metabolism changes caused by gibberellin treatment. The necessity of the relatively low IAA level, however, is supported not only by the development of the high IAA oxidase activity, but also by the fact that male-sterility could not be induced by IAA treatment in our experiments (FRANK et al., 1977), and the fact that the gibberellin-induced male-sterility can be partially reversed by post-treatment with auxin. On the action of 10^{-4} M IAA sprayed prior to flowering, some rows of normally developed hermaphrodite flowers appeared on the heads previously treated with gibberellin (Fig. 3).

The examination indicate, therefore, that a lastingly high gibberellin level is not necessary for male-sterility to be induced, since on third day after the most effective treatment the gibberellin content of the shoot apex no longer increases essentially above the control; flowering occurs only 2–3 weeks later.

The analysed tendency of the changes in the hormone content rather suggest that the gibberellin/auxin ratio developing within 3 days after the treatment may be responsible for the male-sterility.

As the data relating to this field are rare in the literature, and the sex-determining effects of the hormones on the individual species are different, it is hardly possible to compare the experimental and literature data. It may be mentioned that, in studies of flower-buds of various sexes of cucumber, MACIEJEWSKA—POTAPCZYKOWA et al. (1972) and RETIG and RUDICH (1972) found the IAA oxidase activity to be higher in the female ones. Similar investigations relating to hermaphrodite flowers are deficient, however.

Gibberellin is known to inhibit the IAA oxidase activity and thus lead to a high IAA level in certain objects (GALSTON, 1959; HOUSLEY et al., 1961; PILET and WURGLER, 1958; VARGA and BÁLINT, 1965).

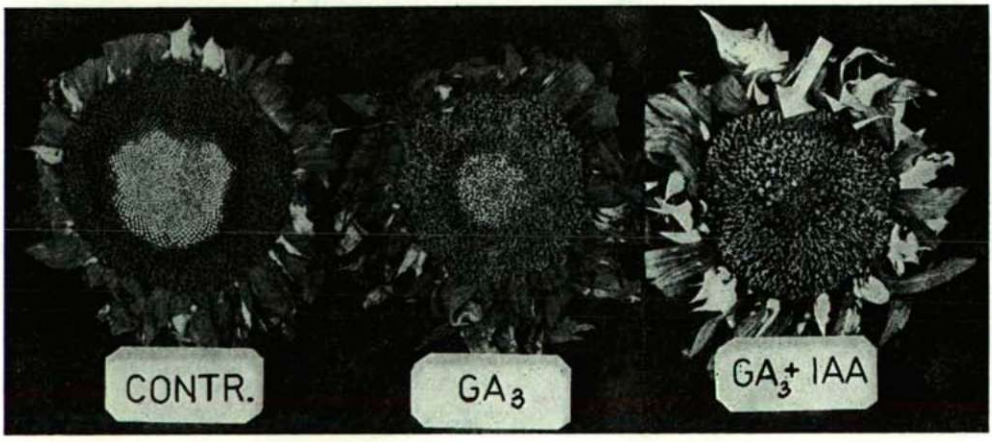

Fig. 3. Sunflower inflorescences.
Control = untreated, normal; GA_3 = treated with gibberellinic acid, male-sterile; GA_3+IAA = treated with gibberellinic acid, post-treated with IAA — some rows of normally developed hermaphrodite flowers appeared.

VALDOVINOS et al. (1967) studied the effect of gibberellin on the decarboxylation of IAA in sunflower seedlings, but found no effect. In seedlings of other plants, however, e.g. wheat and barley, gibberellin treatment stimulated the activity of the enzyme (BOLDUC et al., 1970; GASPAR et al., 1967).

The above experimental results, therefore, indicate that the increase in the IAA oxidase activity as a result of gibberellin treatment may be an alternative reason for the devrease in the IAA content; however, it is also possible that the low IAA evel dvelops indirectly.

Fig. 4. Sunflower flower 1. normal = untreated, 2. male-sterile = treated with GA_3.

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HASTENING GERMINATION OF CROP SEEDS AND SEEDLING GROWTH WITH GIBBERELLIC ACID

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Abstract

Crop seeds were treated with solutions of GA_3 at different concentrations, for hastening germination and the growth of seedlings. In general, the percentage of seeds germinating and the speed of germination increased proportionally with the concentration and at rates differing according to species.

The GA-concentration needed for the greatest stimulation of shoot growth was different according to species, but for most seeds, 500 ppm and 12 hours of treatment proved to be the most effective.

From seeds responding to GA treatment with a shortened germination period seedlings emerged earlier and more uniformly from the soil than those from untreated seeds.

The dry-weight loss of germinating seeds was increased by GA-treatment, and is an index of that.

Amylase and protease activity in the germinating seeds was considerably increased by GA-treatment and the quantity of starch and protein degraded is proportional to the germination period and the weight loss of the seeds. There seemed to be a parallel increase, induced by GA-treatment, of the activities of the hydrolytic enzymes and the elongation of seedlings.

GA-treatment is, therefore, suitable for hastening the germination of crop seeds. This is particularly valuable in the case of slowly germinating seeds where even the percentage of seeds germinating can be considerable increased by GA-treatment.

Introduction

Of the various physiological effects of gibberellins, one of the most important, both from the theoretical and practical points of view, is that they can considerably stimulate the germination of various seeds. In this way, they can assure a more rapid and more uniform emergence of the seedlings (WEAVER, 1972). In the case of crops, early germination and the rapid growth of seedlings are particularly advantageous, because of decreased susceptibility to insect and disease hazards, and also, owing to the possible earlier marketing of the yield. Germination may often be accelerated by soaking seeds in a GA-solution (HAYASHI, 1940; BURNS et al., 1966) or by incorporating GA in a seed protectant slurry (WITTWER and BUKOVAC, 1957; 1958).

The aim of our work was to select from the seeds of some cultivated crop plants, those species responding to GA-treatment by faster germination and growth and further, to establish the GA concentrations required for stimulated germination of seeds and optimum growth of the seedlings. If GA-treatment advances seedling emergence by even a few days, then the procedure may already be considered successful. The GA-induced hastening of germination is closely related to the effect on

synthesis and activity of the enzymes mobilizing storage reserves. Therefore, we have investigated, in a few cases, how much the hydrolytic enzyme activity was affected by our GA-treatment. In addition, we have examined the correlation between the activity of these enzymes and the GA-induced germination and growth.

Materials and Methods

Experiments were performed with seeds and seedlings of the following plants: wheat "Kompolti", barley "Sörárpa", corn "Arany mazsola", bean "Cherokee", pea "Chrestenens", cucumber "Rajnai fürtös", red pepper "Szentesi fehér" and tomato "Kecskeméti merevszárú".

The gibberellic acid used for the treatment of seeds was GA_3 (Phylaxia).

Pretreatment of seeds with GA and germination in Petri dishes

The seeds (50 pieces) were soaked at room temperature for twelve hours in GA_3-solutions at concentrations of 50, 100, 500 and 1000 ppm. (In previous experiments, a 12-hour soaking time proved to be most effective). As controls, some seeds were soaked in distilled water. Germination was carried out in large Petri dishes, in the dark at 25 °C with each seed being in identical conditions of moisture. The number of germinated seeds and the length of shoot and root were recorded daily for five days. Four replicate experiments were carried out.

Examinations of the emergence of seedlings from soil

The seeds (30 pieces in each case) were sown, after being soaked in a GA-solution at 500 ppm for 12 hours, into dishes containing an equal quantity of soil. Seeds sown in the same way and soaked in distilled water were used as controls. Germination and growth were performed in a phytotron (CONVIRON Cabinet Model EF 7, at 25/20 °C day/night temperature, 16-hour illumination, 10 000 lux, 64 percent relative humidity). The soil of dishes was identically watered with tapwater. The number and shoot growth of the emerged seedlings were followed carefully for two weeks. The experiments were also carried out as four replicates.

Measuring the loss of dry weight in germinating seeds

The dry weight of 6-day old germinating seeds was compared with the dry weight of non-germinated seeds as an initial value. The decrease in dry weight was considered as one of the indices of the utilization of food reserves.

Determination of amylase activity

The amylase activity of wheat grains, treated with GA and untrated, were measured on days 3, 6, 9 and 12 of germination, with the process used by VARGA et *al.* (1967) and MIERZWINSKA (1975).

The amylase was extracted from 1 g germinating wheat grain with 15 volumes of cold phosphate buffer (pH 5.3). The homogenate was centrifuged at 28 000 g for 30 minutes at 0 °C. The supernatant was made up to 20 ml. with the same buffer and this was used as a crude enzyme extract. The substrate was a 1 percent solution of soluble strach, made with phosphate buffer (pH 5.3).

The reaction mixtures (3 ml enzymatic extract+3 ml substrate; or, for the blank reaction, 3 ml buffer instead of enzyme) were incubated at 35 °C for 30 minutes, then 1 ml samples were taken into test-tubes containing 10 ml 0.05 N HCl. The

initial starch concentration was determined from the blank reaction mixture, from the sample withdrawn at zero time. 0.5 ml KI-KIO_3 solution was added to the test-tubes and the intensity of the blue colour produced was measured at 580 nm, with Spectromom 202 photometer. Amylase activity was expressed as the weight (in mg) of starch degraded in 30 min., by the enzyme extracted from 1 g of germinating seed.

The activity of α- and β-amylase was determined separately by heating a part of the enzyme extract in a water bath at 70 °C by which procedure β-amylase is inactivated. With this enzyme extract the α-amylase activity could therefore, be determined. Subtracting this value from the value obtained with the unheated preparation gave a measure of the β-amylase activity.

Measurement of protease activity

The protease activity of the GA-treated and control pea seeds was measured according to HARVEY and OAKS (1974a; 1974b), on the first five days of germination.

Fozen cotyledons were homogenized in a cooled mortar with cold acetate buffer (pH 3.8). The homogenate was centrifuged at 28.000 g for 30 min. at 0 °C. The supernatant was assayed for proteolytic activity with a 5 percent solution of albumin, prepared from dry pea seeds, as substrate. Each reaction mixture contained 2.0 ml of substrate, 0.5 ml of acetate buffer 0.05 M (pH 3.8), 2.5 mM EDTA, and 0.5 ml of enzyme in a total volume of 5 ml. The blank was made with boiled enzyme. The mixture was incubated for 15 min. at 40 °C, and the reaction was stopped by adding an equal volume of 5 percent TCA. Protease activity was measured as the increase in absorbance at 280 nm of the TCA-soluble fraction, and was arbitrarily calibrated against the absorbance as mg tryptophan released from protein per hr per seed.

The laboratory examinations were performed in triplicate.

Results and discussion

1. Effect of soaking seeds in GA-solution on germination and seedling growth

We have found only very limited data in the literature concerning the stimulation of germination and seedling growth by treating crop seeds with GA-solutions, and further, what GA-concentrations are effective on the diverse seeds. Taking into consideration the presumably different reactions of the individual species, we have chosen and tested, for our experimental seeds, a concentration range from 50 to 1000 ppm.

Results of germination in Petri dishes

By germinating the seeds in Petri dishes, we were able to examine the GA-effect on the speed of germination and percentage of seeds germinating as well as on the rapidity of seedling growth.

Examining the *speed of germination* (Table 1), it is obvious that hastening of germination is expressed in every species in days 1 and 2 after pretreatment. The increased speed of germination is very striking with cucumber, barley, corn, pea

Table 1. The speed of germination and germination percentage of seeds presoaked for 12 hours in GA-solutions of different concentrations. (n=4×50)

Seeds	GA conc. ppm	Days					Germination percentage
		1	2	3	4	5	
		Number of germinated seeds					
Wheat	0	40	48	48	48	48	96
	50	43	49	50	50	50	100
	100	45	50	50	50	50	100
	500	46	50	50	50	50	100
	1000	45	50	50	50	50	100
Barley	0	5	37	43	43	43	86
	50	5	42	42	43	45	90
	100	16	42	43	45	46	92
	500	16	44	45	45	46	92
	1000	19	40	43	45	47	93
Corn	0	—	15	21	30	32	64
	50	—	19	24	38	40	80
	100	—	28	38	44	45	90
	500	5	27	36	42	42	84
	1000	3	26	41	45	45	90
Bean	0	20	39	42	45	45	90
	50	21	43	45	46	46	92
	100	22	42	44	46	47	93
	500	23	44	46	47	47	93
	1000	24	43	46	46	46	92
Pea	0	—	18	25	26	30	60
	50	—	20	28	30	32	64
	100	3	25	33	34	34	68
	500	5	27	35	38	38	76
	1000	5	27	36	39	40	80
Cucumber	0	25	41	47	47	47	93
	50	33	47	48	50	50	100
	100	32	46	50	50	50	100
	500	43	48	50	50	50	100
	1000	44	50	50	50	50	100
Red pepper	0	8	22	30	34	36	72
	50	7	25	34	37	37	74
	100	10	25	35	37	38	76
	500	10	24	37	40	41	82
	1000	12	26	36	40	40	80
Tomato	0	1	10	27	32	38	76
	50	—	13	30	38	38	76
	100	2	12	32	39	39	78
	500	3	17	38	42	43	86
	1000	3	15	33	41	41	82

and red pepper, but with wheat, bean and tomato seeds the effect is rather less obvious. In days 1 and 2 after pretreatment the effects of GA appear to be related to its concentration. In succeeding days the differences between the GA-treated and untreated, control, seeds become much less marked. The increase in germinating speed is greatest with barley, corn, pea and cucumber seeds.

Although indicated by previous reports (WEAVER, 1972) that the final *germination percentage* is not considerably increased by GA-treatment, we have nevertheless observed, in our experiments, a rise in the germination percentage of most species, with generally bears a direct relationship to GA-concentration (Table 1). As compared with the control, the rise in the final germination percentage is highest in the case of corn (+26 percent), pea (+20 percent), red pepper (+17 percent), and tomato (+10 percent). On the other hand, virtually no increase was observed with wheat, barley and bean seeds (+3 to 4 percent), wich germinated well, even without GA-treatment.

It can be ascertained on the basis of our results that the GA-treatment applied by us is suitable for hastening the germination of several crop seeds. This effect is particularly noticeable with seeds germinating comparatively slowly without any treatment, where an increased percentage of germination, ranging from +10 to +26 percent, could be achieved with GA pretreatment. The method is, therefore, noteworthy from practical point of view.

The *shoot growth* of seedlings originating from seeds treated with GA-solutions of different concentrations is shown in Fig. 1. The stimulative effect of GA on shoot growth begins to be conspicuous from the 4th day of germination and is the most vigorous between days 4 and 5. This is best observed in the case of wheat, barley, pea and cucumber. According to our data, cucumber, then barley, corn and bean seedlings respond most strongly to GA-treatment with an increased shoot growth. The GA-concentration needed for maximum stimulation of shoot growth is different according to species. For tomato, treating with a solution of 100 ppm of GA, for pea and bean with one of 1000 ppm, and for the other four species, treating with a solution of 500 ppm, proved to be the most successful. It can also be shown that the GA-concentrations stimulating maximal germination or maximal shoot growth are different, at least for the majority of species.

In our experience, *root growth* of seedlings is also stimulated by GA, apart from a few exceptions, in a contentration dependent manner.

Results of sowing into soil

For sowing into soil, the seeds were pretreated for 12 hours in a GA-solution at a concentration of 500 ppm, proved previously to have an optimum effect. In these experi mnts, the emergence of seedlings and the rapidity of their growth were followed closely.

The growth of the emerged shoots was stimulated, in the majority of species, by GA-treatment, but in different ways and to different degrees. In the case of wheat and bean, where no considerable hastening of germination is induced by GA, an increased shoot growth could only be observed after days 4 to 6 and thus, emergence from the soil was not enhanced considerably. The degree of growth stimulation was +17 percent and +14 percent, respectively, at the end of the experimental time (Fig 2). On the other hand, the seedlings from barley, corn, pea and cucumber

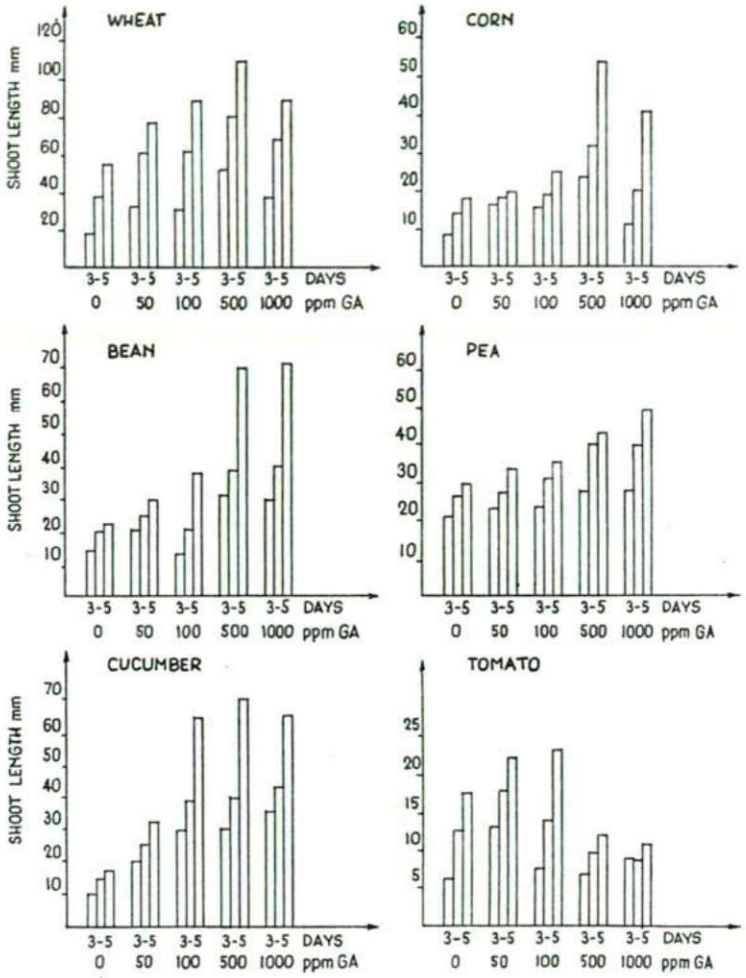

Fig. 1. Shoot growth of seedlings growing from seeds treated with GA-solutions of different concentrations.

seeds, which responded with accelerated germination to GA-treatment, emerged earlier than controls and, in addition, their shoot was longer from the time of emergence. In this group we have observed a growth stimulation ranging from +28 to +40 percent at the end of the experimental period (Fig. 3). These results partly agree with HAYASHI's report (1940) who experienced a more rapid germination and stimulated shoot growth of barley and rice grains soaked in GA-solution.

The emergence of seedlings originating from treated seeds is therefore correlated with the GA-effect on speed of germination. The stimulation of shoot growth is, on the other hand, considerable for every species. Enhanced stem elongation is also

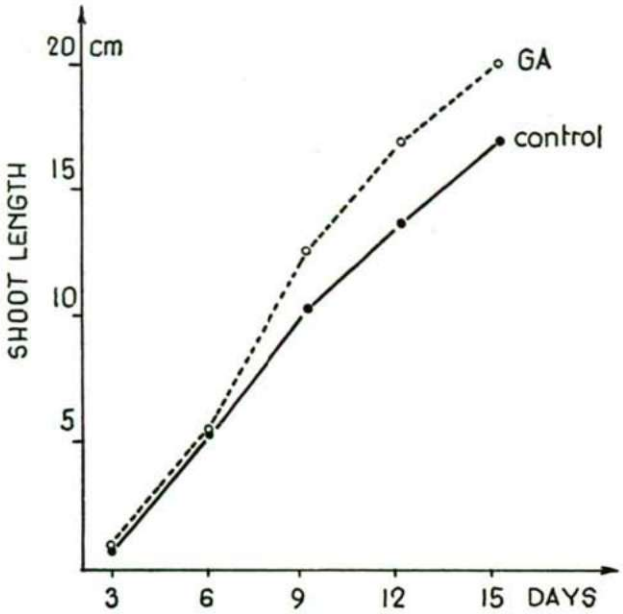

Fig. 2. Shoot growth of bean seedlings, from GA-treated and untreated seeds, after emergence from soil.

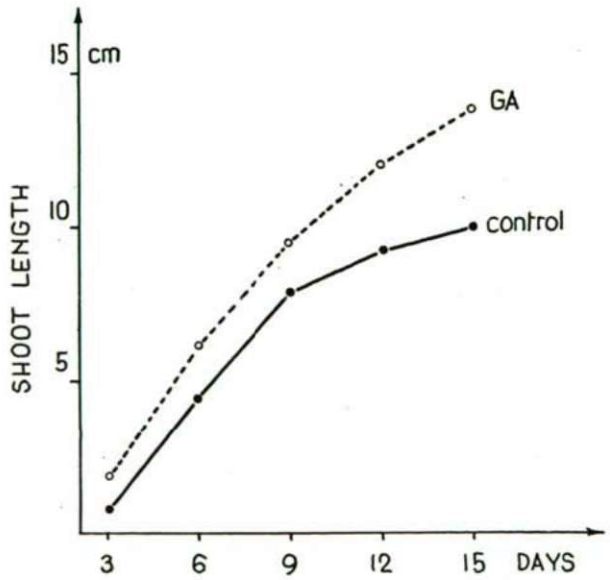

Fig. 3. Shoot growth of cucumber seedlings from GA-treated and untreated seeds, after emergence from soil.

accompanied by a noticeable leaf expansion and the treated plants generally seem to be more vigorous than untreated controls. GA-treatment does not result, therefore, in an etiolation-type shoot growth.

2. Effect of GA on dry-weight loss of germinating seeds

According to our results, the percentage of dry weight of wheat and pea seeds, germinated in GA-solution at a concentration of 500 ppm, is considerably smaller on day 6 of germination than that of the control germinated in tapwater (Table 2). This observation reflects more rapid and intensive germination and an increased seedling growth. The mobilization of endosperm reserves and their utilization by the seedling was increased by GA by 30–33 percent. The weight loss taking place during germination is proportional, both with wheat and pea, to the intensity of germination and growth, i.e., it is a good indicator of these processes.

Table 2. Effect of GA-treatment on the loss of dry weight of germinating seeds

Species	Seeds germinated in tapwater	Seeds germinated in GA-solution	Effect of GA on dry weight loss %
	dry weight % on the 6th day		
Wheat	8.8	6.1	30.7
Pea	7.2	4.8	33.4

3. Effect of GA-treatment on hydrolysis of starch reserves

From those seeds where the main storage product is starch, we have chosen wheat for the present experiments. The effect of the 12-hour long GA-pretreatment of 500 ppm, on the $\alpha+\beta$ amylase activity of germinating wheat grains is shown in Fig. 4. According to the data, during the 3–12 days of germination more starch reserves were degraded in the endosperm of the GA-treated wheat grains; that is, amylase activity was more increased than in control seeds. It is obvious, therefore, that the dry-weight loss of the GA-treated wheat grains is a result of a more intensive mobilization of the reserved starch.

The difference between the amylase activity of controls and the GA-treated grains was the greatest at the beginning of germination (on the third day +35 percent). As germination and growth advanced, amylase activity declined. The greater initial enzyme activity of GA-treated seeds corresponds to the hastened germination observed in the first days.

According to our present knowledge, GA stimulates germination at a genetic level, by inducing the synthesis of the enzymes that hydrolyze the endosperm reserves. The hormone derepresses the genes responsible for the hydrolytic enzyme synthesis. The increase of the GA-induced enzyme activity is, therefore, based upon a *de novo* protein synthesis. A great number of publications concerning the enzyme inducing effect of GA have appeared to date. These results have been reviewed recently by MARCUS (1971), JONES (1973), MAYER (1974), and JACOBSEN (1977).

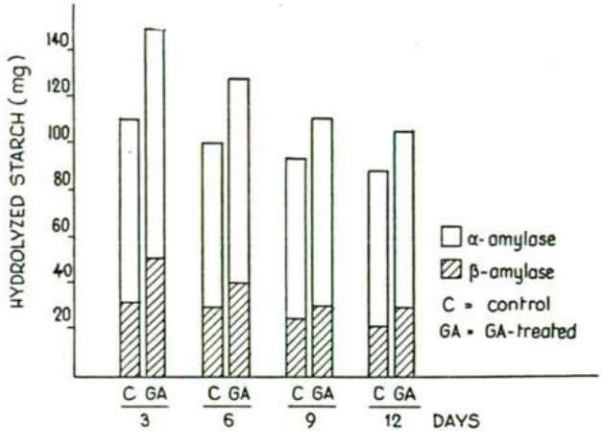

Fig. 4. Effect of GA on the amylase activity in germinating wheat grains.

4. Effect of GA-treatment on the mobilization of protein reserves

The GA-effect on the formation of protease activity was measured in the germinating pea seeds, which contain a considerable quantity of protein, for six days. The treated seeds were soaked for 12 hours in GA-solution at a concentration of 500 ppm. Controls were soaked in tapwater. The rate of the protein-reserve degradation was considerably increased during germination by the GA-treatment of pea seeds (Fig. 5). The GA-induced increase in protease activity was greatest on days 2 and 3 of germination (+75 and +73 percent). This coincides with the increased rate of germination as observed in treated seeds on the same days. As germination advanced, the difference between the protease activity of treated and untreated pea seeds decreased to some extent but the increased mobilization of the protein in the treated seeds could be distinctly observed even on the sixth day (+33 percent).

5. Connection between the GA-induced enzyme activity and the shoot elongation

The stimulating action of GA on the synthesis and secretion of some hydrolytic enzymes has been noted many times. Much less is known about the relation between the enzyme activity and seedling elongation induced by GA.

KATSUMI and FUKUHARA (1969), after treating seedlings of dwarf corn mutants with GA_3, found that amylase activity increased in parallel with shoot elongation. This was, however, not observed in isolated bean hypocotyls exhibiting a high amylase activity, stimulated by GA-treatment (CLUM, 1967). Incubation of alfalfa seeds in a GA_3-solution induced parallel increases in proteolytic activity and hypocotyl elongation (CONEN et al., 1969). On the other hand, MICHNIEWICZ and KAMIENSKA (1969) did not observe a direct correlation between the stem elongation and the activity of hydrolytic enzymes in bean seedlings growing on a medium with added GA. It is, therefore, worth comparing how, in our own experiment, the

GA-induced amylase and protease activity is connected with the shoot elongation of seedlings.

In the case of germinating wheat, amylase activity was increased by GA-treatment by 18 to 25 percent (Fig. 4). Comparing these results with the simultaneous shoot elongation (Fig. 1), we observe a definite correlation.

In germinating pea seeds, protease activity was increased by GA-treatment by 33 to 65 percent (Fig. 5). The GA-induced increased degradation of protein reserves, and the stimulated transport of amino acid components into the seedlings are in full agreement with the shoot elongation data displayed in Fig. 1.

Thus, from our experiments, it would appear that there is a direct correlation between the increased activity of hydrolytic enzymes and the elongation of seedling shoots induced by GA-treatment.

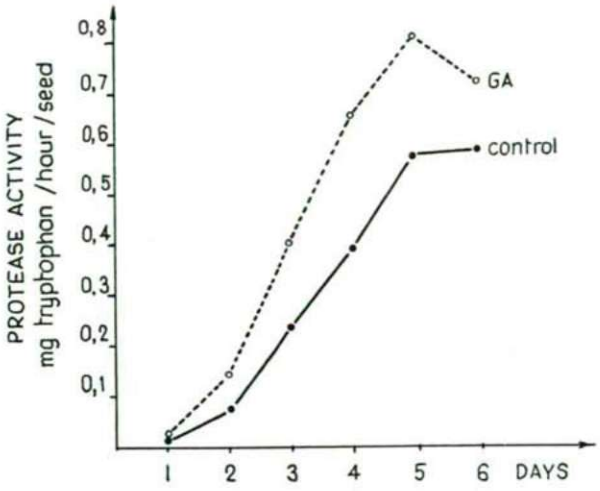

Fig. 5. Effect of GA-treatment on the protease activity in germinating pea seeds.

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Sexuality is a law of nature to which the living world has been subject since its beginnings, just as it is today.
GREGUSS

THE CONSERVATION OF BARYON CHARGE AND THE MANIFESTATION OF PAULI'S PRINCIPLE IN THE LIVING WORLD

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(Received 1979)

Abstract

We have attempted to turn round the traditional biological approach and should like to emphasize in the organization of the inanimate and living world not the difference but what is fundamentally common. We suppose that Pauli's principle and the conservation of the baryon charge manifests itself at the multiplication of cells in the following forms:

1. The genom has — similarly to the proton and neutron (baryon) — an indivisible +1 biological charge. The cells preserve the unit charge in case of division.

2. The "fermion" and "boson" states appear in the animate world, as well.

a) On the basis of the linear arrangement of genes and the 5→3 direction of the transcription, we may order to the "fermions" of the cell a vector number of 1/2 value, a "spin".

b) The molecular fermions at prokaryotic level are: one of the chains ("+" or "−" genom) of RNA and DNA. The "boson" state is represented by the replicative virus RNA with double helix, the RNA–DNA hybrid and DNA.

c) "Fermions" of the eukaryotic cell are: a member of the homologous chromosome pair, resp. a paternal or maternal genome. To the "boson" state, the homologous chromosome pair, resp. the diploid chromosome set correspond.

3. The peculiarity of the genome and chromosome "fermion" manifests itself in the following:

a) The identical gametes don't unite with one another.

b) The identical gametes can "conceal" their "fermion" peculiarity by being inactivated.

c) In homozygotes, in the identical loci of the homologous chromosomes, one of the genes becomes inactivated.

d) The synthesis of rRNA is primarily regulated by the female genome.

4. Hermaphroditism is the specialty but no new acquisition of the living world but it origins from the internal property, organizational basic form of matter. The bilateral (bixesual) organization and sexual polarization show some degrees of evolution.

"Boson" states:	Character and begin of the sexual polarization:
1. Bivalent parity (C^{12}, N^{14}, O^{16} nucleus)	None
2. Molecular diploid (Bacteria)	Gene-level
3. Chromosome diploid (Eukaryote)	Genome-level
a) Hermaphrodite	At the end of the individual development
b) Monoecia	At the middle of the individual development
c) Dioecia	At fertilization

The editing commission does not agree with some establishments of the paper.

Introduction

It follows from the symmetry of space and time that every law of nature is insensible to any operation of shifting in time and space or turning in space. To any property of symmetry a law of conservation corresponds. In this way, for example, the principle of the conservation of energy follows from the symmetry of nature, shown opposite to the shift of time.

The laws of conservation reflect the fact that in nature an order rules and, from this, we may take the hope that the laws of nature can be recognized.

The law of conservation of the number of fermion (baryon, lepton) is one of the most exact laws of nature. One of its consequences is that our Galactic System did not disintegrate into light particles and radiation and, therefore, the atoms, molecules, and the living world could develop.

With the evolution of the living world, matter became more ordered in several ways. The important question is, which of the laws demonstrated in inanimate nature, are also apparent in living organisms. When we look for the effects of the laws of conservation and of the principle of exclusion in living world, we do not expect to find an obvious manifestation of these physical laws but of their appearance at a higher level, in another form.

In this paper, I wish to discuss the following points:

1. I propose that, in the living world, the various types of cell multiplication are processes by which the number of fermions is preserved.

2. I survey the main types of zoogamy from a somewhat novel standpoint and attempt to connect the laws of meiosis with Pauli's principle.

3. I attempt to show that one of the most important "inventions" is sexuality, the origins of which, far from being a recent phenomenon, are effects of the principle of exclusion and, as such, are determined by the state of subatomic particles.

1. Conservation of the fermion charge in the living world

Over an extremely wide spectrum of diverse forms, matter may be considered to exist in three main states: (a) matter as radiation; (b) inanimate matter having a rest mass; (c) animate matter. The creation and stability of the three matter-forms of essentially different quality are guaranteed by the laws of conservation.

According to the second law of thermodynamics, matter has a higher entropy in the form of radiation. On the basis of the considerable stability of the proton, WIGNER (1976) demonstrated that atomic matter does not disintegrate into radiation because the heavy fermions (baryons) carry a baryon charge. The proton does not disintegrate because it is the lightest carrier of the baryon charge and, on decomposition, it cannot transfer its baryon charge to its successors.

Before the elaboration of the neutrino theory of two components — LEE and YANG (1956, 1957); LANDAU (1957) —, MARX (1953) was the first to recognize that a so-called lepton charge can be assigned to particles of half odd-integral spin (leptons). The law of conservation of the number of fermions (baryons, leptons) is one of the most exact laws of nature. The law postulates that if a fermion number of value $+1$ is assigned to every particle of half odd-integral spin and to antifermions the value of fermion number -1 is assigned, then, for all known physical processes, the algebraical sum of the fermion numbers is strictly conserved.

The conservation of fermion number does not mean, even in the world of nucleons, indistructibility, immortality, but does give rise to the extraordinary stability of the proton and electron.

In the living world, conservation of the baryon number ensures the following: the ability of the individual to multiply independently, the "immortality" of cells; and this, *in ultima analysi,* manifests itself in the stability of species.

(A) We endeavour to show the fundamentally common principle underlying extremely diverse physical and biological phenomena: At the eukaryotic cell level, the complete set of haploid chromosomes may be considered as a unit group and hence assigned a unit "biological charge" of +1. This is named, after WINKLER (1920), a genome. The genome has this "charge" property, analogous to that of particles of half-odd integral spin (baryon). On the other hand, conservation of baryon charge means that during cell multiplication, chromosomes may be combined in very different ways but their "+1 biological charge" remains. Such a "charge" assignment is a strict unit; it cannot be divided into fractions without breaking the law of conservation. For the real diploid individuals even nullisomia is already lethal.

(B) In the diploid cell (of "+2 charge") there are two (paternal and maternal), but not identical, genomes of identical chromosome number and very similar mass and structure. In the somatic cell-cycle the two genomes are structurally independent of each other, but in meiosis, at the time of pairing of homologous chromosomes, the two genomes form a single, integrated system (boson). Therefore, their conservation shows a mutual dependence.

(a) In mitosis, the sum of chromosomes (n) of paternal (A) and maternal (a) origin in the daughter cell, is equal to the chromosome number of the parent cells.

(b) The two genomes (i.e. maternal and paternal) can only be propagated together; the chromosome number preserved during division; doubling only the paternal or maternal chromosomes, is therefore prohibited.

(c) As the smallest haploid chromosome number remains unchanged even if the two genomes multiply, the hermaphrodite plants often have polyploidia.

(C) Cells that lose their merismatic ability will sooner or later perish. The bacterium and unicellular are constrained by the principle of conservation to carry out many thousands of biochemical reactions, transformations with a single "aim": to produce two young cells, each of which is identical with the parent cell. These cells are potentially immortal.

The gametic mother cells of multicellular are continuously dividing some of the games become immortal as a result of fertilization. According to Huzella (1953), every individual of the Metazoa living today is derived from the first, primordial germ cell by means of a deathless, endless cell series.

2. The main types of sexual process

In the zygote, the conservation of the haploid chromosome number is ensured by meiosis. In mitosis, the formation of genomes is characterized by the change: 1 "boson"→2 "bosons", and in meiosis by the change: 2 "bosons"→8 "fermions"→ →1 "boson". Theoretically, 1, 2, 3, or 4 zygotes could be produced from the union of the gametes derived from two diploid parent-cells. Nevertheless, if we survey the zoogamic forms, we observe that invariably only one zygote develops.

(A) Uniparental zygote formation

(a) The autocaryogamy of the diatom Chaetoceras borealis. A diploid cell divides by mitosis into two cell nuclei. This is directly followed by reduction division. From the four haploid cell-nuclei two degenerate (0) and two (isogametes) (0) unite to form a zygote. (Fig. 1).

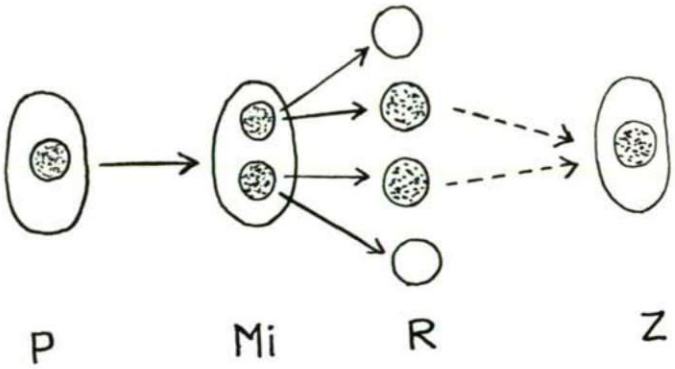

Fig. 1

Scheme of the sexual process of Chaetoceras, according to Chadefaud (1960). P= =parent cell, Mi = mitosis, R = meiosis, Z = zygote. The white circle represents a degenerated cell nucleus.

(b) Autogamy of Actinophrys sol (Heliozoa, an animal monoplast). The diploid cell divides with mitosis into two cells. The sister cells divide with reduction. Two of the four cell-nuclei degenerate (0) and two of them divide thus preserving the number (0). In the second ripening phase, two cell-nuclei degenerate. From the surviving gametes one (of male character) is active in the copulation. Fig. 2.

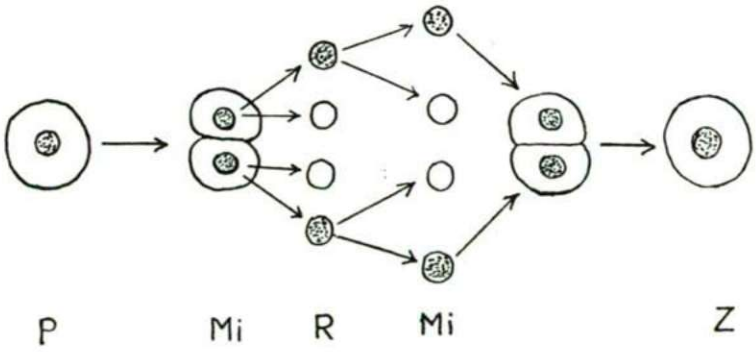

Fig. 2

A scheme of the autogamies of Actinophrys, according to BELAR (1923).

(c) Zoogamy of haploid type of *Hartmannia diploidea* (dispermic amoeba). The cell with dicaryon divides by mitosis into two cells. In the diploid amoeba of

two cells eight cell are produced via reduction division. From these, six degenerate and the remaining two gametes transform with plasmogamy into an amoeba with dicaryon.

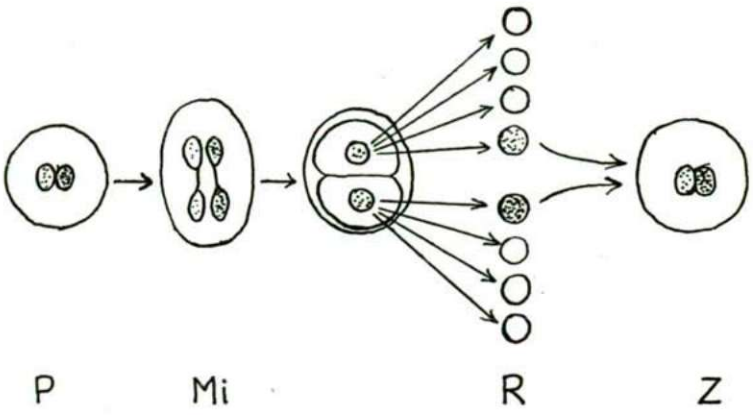

Fig. 3

A scheme of the zoogamy of *Hartmannia diploidea,* according to HARTMANN&NÄGLER (1908, 1956).

The above examples represent the sexual process of monoplasts, the most primitive state of monoecism. The monoparental zygote-formation is, in fact, also bi-parental one because (in the common cell membrane) by bipartition two sister cells (cell nuclei) come about. Fig. 3.

(B) Biparental zygote-formation

(a) Anisogamy of the diatom Chaetoceras borealis. Two different diploid individuals of sexual character align themselves in close proximity and then reproduce first number-preserving, then by redaction division to produce four haploid cell-nuclei each. Two of the nuclei degenerate in each case. In the original cells, sticking together, a smaller gamete of male and a larger one of female character develop in this way. The gametes of male character fuse with the female gametes. Fig. 4.

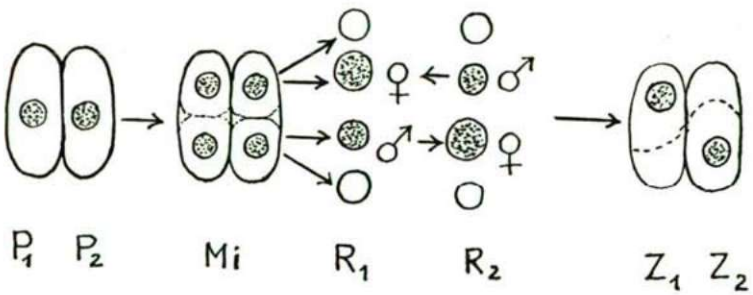

Fig. 4

A scheme of the anisogamy of Chaetoceras borealis, according to Chadefaud (1960).

(b) Conjugation (anisogamy) of *Paramecium*

Conjugation is generally characteristic of the monoplasts (Ciliata) of two kinds of nuclei. Two uniform diploid monoplasts fuse round the edges of their mouths and a cytoplasmic bridge is formed between them. The meganuclei are absorbed and the micronuclei divide, first by mitosis and for the second time by meiosis, creating four descendant nuclei each. From each of these three perish but the fourth nucleus multiplies by bipartition. From this division two nuclei are formed, one of male and another of female character. The male nuclei migrate into the adjacent cell and fuse with the female nucleus.

A scheme of the conjugation of *Paramecia* (Fig. 5).

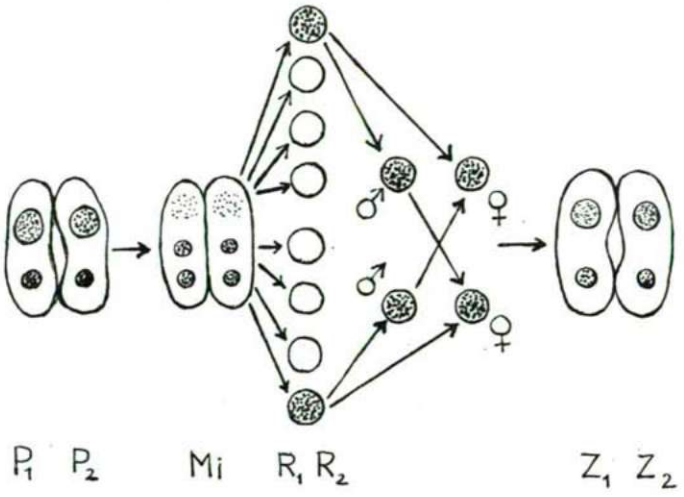

Fig. 5

The number of zygotes produced by iso- and anisogamy corresponds to the number of the parent cells. At oogamy, one zygote is formed from two diploid sexual mother-cells.

(C) Zygote formation by oogamy

The diploid primitive gametes (primitive ovum, primitive spermatozoon) multiply by mitosis so that fewer oogonia and many spermatozoa are formed. Following this, the descendant cells develop into the large oocytes or into the small spermiocytes (i.e., into macro- and microspore mother-cells respectively). Then, in the first maturity phase, they divide by meiosis into two haploid cells. At the end of the second maturity phase (mitosis), four haploid gametes are formed. In the course of the development of oocytes three cell nuclei are absorbed.

The large, immobile ovum encounters and is fertilized by a male gamete. From two diploid cells one zygote is formed. (Fig. 6)

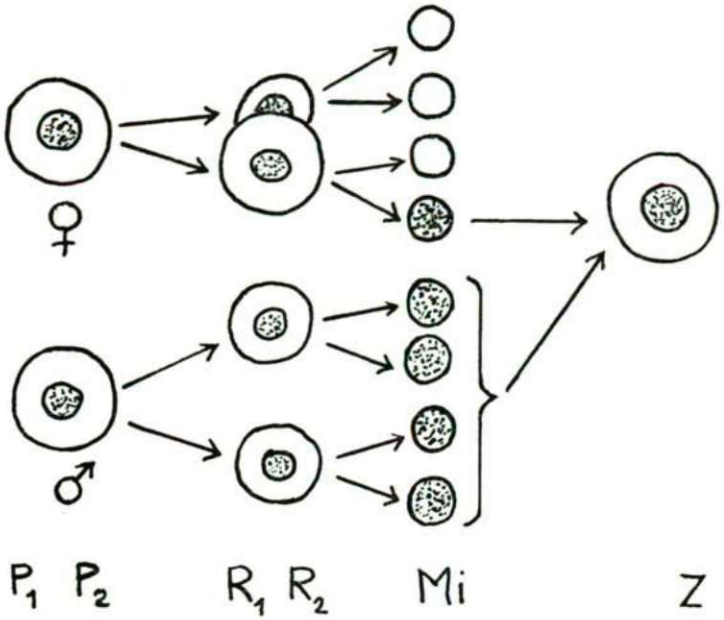

Fig. 6

A scheme of the development of the zygote formed by oogamy (Fig. 6).

The parent cells (P) are in the micro- and macrosphere mother-cell phase. This most developed form of zoogamy is general among the higher living beings (Cormophyta, Acoelomata, Coelomata).

It is, therefore, unambiguously valid in the animal and vegetable kingdoms that from the four haploid cells, formed from the primitive ovum by reduction division, only one becomes fertilized. Question: What is the cause of this?

3. The formations of the cell and Pauli's principle

Despite the general nature of the phenomenon, there is, as yet, no satisfactory attempt in the literature to answer the question, why three cells must perish in the course of the macrosporogenesis. Professor A. ÁBRAHÁM (1977) has suggested a plausible answer, "One of them is surely too many".

Translating this reply into the language of science, we obtain one of the most general laws of nature, Pauli's principle. This principle governs the behaviour of protons and neutrons during the formation of an atomic nucleus. (There is no known stable atomic nucleus consisting of two or more proton. Every atom and, hence, the whole periodic classification of the elements is built on this principle.

Pauli's principle has more than one known formulation:

(A) According to Pauli's original formulation (1925): more than one electron cannot be in the same quantum state. The principle of exclusion, first proposed for

the electron, was later proved to be of general validity for any particle having odd half-integral unit of spin angular momentum (fermion).

(B) According to the second definition: the state-functions of the identical particles of half spin are antisymmetrical, but those of the identical particles having whole spin are symmetrical (1963). The particles having whole spin are termed bosons, those having half spin are fermions. DIRAC (1928), GYÖRGYI (1965).

(C) The third definition of Pauli's principle of exclusion: identical fermions must be separated from one another WEISSKOPF (1973).

It is very useful to state Pauli's principle in detail, and it leads me to the following hypothesis:

(a) The basis of the organization of matter is the formation of the bivalent parity (bosonistate) and the change in the fermion-boson state.
(b) The fermion and boson states also appear in the living world.

At the macromolecular level the fermion state is represented by virus-RNA, pre mRNA and mRNA, as well as by one (+) or other (−) strand of DNA. The boson state is demonstrated by the double-stranded forms of the nucleic acids: the double-stranded virus RNA and the DNA (bacteria, blue-green algae), consisting of a double helix.

The boson state is demonstrated at the eukaryotic cell-level by the homologous pair of chromosomes, and the fermion state is represented by one of the members of the homologous pair of chromosomes or by the haploid chromosome set.

According to the rule of the addition of moments of momentum — MARX (1964), —, from among the four possible spin states (S) of the two different fermions: three may be symmetrical (↑↑): S=1 0,−1 triplet; and one (↓↑) may be singlet: $S=\frac{1}{2}-\frac{1}{2}=0$ state. It is possible to consider the two chains of DNA ("boson") as the singlet state of the two different "fermions". And the homologous chromosomes are in the triplet state at the time of conjugation.

The linear arrangement of genes on the chromosome and the 5→3 direction of the transcription gives a vector character to the chains of RNA and DNA, as well as to the chromosomes. Half a "moment of momentum" may be assigned to a chromosome. According to the vector model of the quantum theory: the resultant of the half-spin of a pair of chromosomes is always an integer — that of an unpaired chromosome is a half. If an integral and a half angular momentum are added up, the resultant will always be a half, GYÖRGYI (1965).

4. The lethal incompatibility of oocytes

The fact that, in the course of oogenesis, three occytes always perish, may be explained if there is always genetic incompatibility between the members of the original set of four oocytes. This incompatibility arises during meiosis. If, after meiosis, zygote formation is not preceded by mitosis (cf. Fig. 4), then only one cell perishes. As regards our central question, why only one ovum ripens, the following answer may be given:

(A) In the course of mitosis, homologous chromosome pairs (bosons) are included in the daughter-cells. For bosons, Pauli's principle is not valid: they can

multiply in the same state, in the same cell. In plants, there is frequently a mitosis in which chromosomes pass only through the S-phase, a process which may be repeated several times, the cell only differentiates after that. FRIDVALSZKY (1972). The endomitotic politenia of Diptera is also well known. Endomitosis is frequent in the vegetable kingdom under natural conditions. GEITLER (1953). On the other hand, the disruption of the nuclear membrane is not required. In the course of mitosis, the chromosomes should reach anaphase MAZIA (1963).

(B) In meiosis, the members of each homologous pair separate from each other (fermions). Before this, at the zygote stage, the homologous chromosomes (fermions) of paternal (A) and maternal (a) origin unite to form a structurally double-particle (boson) system (triplet state). Two conditions pertaining to the pairing of the homologous chromosomes should be mentioned: First, at the zygote stage, the newly synthetized DNA differs in base composition from that synthetized during the S-phase, STERN & HOTTE (1939); on the other hand, the formation of the synaptic complexes MOSES (1932).

Crossing-over increases the identity of homologous, and dissipates the inactive genes. The identical fermions differentiate. The fundamental "sense" of the crossing-over is, therefore, the separation of the homologues of paternal and maternal origin. The selection could not be achieved by the filament of the nuclear spindle.

Such a "reduction" division — as opposed to endomitosis — in which the homologues reman together at the end of the prophase and diploid gametes are formed, is unknown. Polyploid formation of such a character is unknown.

5. Reversible inactivity of male gametes

In animals, it may be considered that the main cause of the oocytic and polycytic "contrast" is the sex chromosome. In mammals, the female sex is characterized by XX and the male sex by XY chromosome pairs. From the oogonium cell, for instance, in human four oocytes (fermions) of 22+X chromosomes develop. The cause of the lethal incompatibility is that closely similar fermions arise. From the primordial spermiocytic cell of the male two 22+X and two 22+Y sperms develop. Between the two spermatozoa with X and the two with Y, incompatibility ought to exist; but it does not!

It is, however, unambiguous that Pauli's principle cannot distinguish between sexes! How is it then that, in the living world, four identical spermatids are formed from the spermatogonium?

There are two possibilities to "deceive" the principle of exclusion:

(a) The developing haploid cells have to conceal their "fermion"-character.

(b) After having developed, they must immediately separate from each other with an oolemma or a cell wall.

And, indeed, CHEN and RUDDLE (1971); ARRIGHI and HSU (1971); JOHN and LEWIS (1975) have demonstrated that in most mammals the chromosomes X and Y are inactive (heterochromatic) at the time of spermatogenesis. In oogenesis, however, the two X chromosomes are active (euchromatic).

In most plants, there is no sexual chromosome; nevertheless, the generative cells — in a similar way to the animal sperm — "conceal" their fermion-state. In 1964, numerous haploid calluses: embryos and plants were produced from Anthera cultures. VASIL and NITSCH (1975), in their comprehensive work, have evaluated

the results so far and shown that haploid was obtained from 56 flowering plant species. But it is startling that they could not show any case where they successfully induced a dividing callus from the generative cell.

According to VASIL and NITSCH, this is surprizing since they obtained several haploid plants from female gametes in natural and in artificial ways.

The generative nuclei are heterochromatic, genetically inactive, in which RNA synthesis is presumably minimal.

One of the most impressive instances of the effectiveness of Pauli's principle is the development of pollen. In the tetrad, the division into two identical fermions is ensured by the thick pollen wall. The single-seeded microspore soon divides in two but the vegetative and generative cells are separated by walls. After the generative cell is divided into two, the sperms become inactive.

6. Is the RNA-synthesis regulated by the female genome?

The incompatibility of identical gametes is supposedly realized in the cytoplasm. The cytoplasm of animal sperms is generally small. The vegetal generative nuclei are generally surrounded by an also hardly discernible, slightly basophilous plasm. By fertilization, almost nothing but the sperm gets into the gigantic cytoplasm of the ovum. Several theories and contrary opinions can be put forward for the molecular evaluation of the transitory inactivity of male gametes at molecular level, with regard to their biological importance. For us, the most probable cause seems to be that ribosome synthesis in the diploid cell can only be regulated by one of the genomes.

It is supposed to be extremely important from the point of view of the genetic stability of the somatic cells and the strictly arranged synthesis of ribosomes that the gene of the precursor of 28 S and 18 S rRNA (45 sRNA) should not be active outside the ovum. More than one datum proves — GALL&PARDUE (1969); GREEN & GERARD (1974); MAHDAVI & GRIPPA (1972) — that the synthesis of the ribosome proteins takes place in the nucleolus, strictly in order and the nucleolus is left by already ready ribonucleo-proteids.

The pre-rRNA genes, connected with the chromosomes organizing the nucleolus, are in the so-called "nucleolus-organizator" region. RITOSSA & SPIEGELMAN (1965). In the male sex gametes this chromosome region is probably inactive. We failed, therefore, to discern a nucleolus in sperms.

What would happen if after fertilization the rRNA genes were activated in the male genome, as well?

RNA-depending DNA-polymerases were found even in embryonal cells that were certainly not infected by any virus. TEMIN&BALTIMORE (1971), GREEN&GERARD (1974). According to TEMIN, in the S-phase of the cell-cycle, the DNA→DNA redoubling ensures the constancy of the genome of cells, while the reverse transcription DNA→RNA→DNA ensures the genetic variability, differenciation of cells.

It was proved in the course of the oogenesis of XENOPUS LAEVIS — BROWN& TOCCHINI—VALENTINI (1972); GALLO (1972) — that at the beginning of the meiosis, the number of genes encoding rRNA in the oocytes quickly increased 1000 to one. The experiment was so evaluated that a gene replication, amplification took place independently of the redoubling of DNA. The amplification of rRNA genes began by the transcription DNA→RNA, then the rRNA molecule served as templat for

the reverse transcription and a RNA—DNA hybrid was formed, and that was transformed by the DNA polymerase into double-chained extra-rDNA.

In the ripe ovum the rDNA-gene amplification stopped, the extra rDNA copies, however, could be integrated into the genome of the male gamete. If the RNA reverse transcription also took place during the meiosis of male gametes or if the synthesis of ribosomes were directed parallel with the female genome by the DNA→RNA protein information in transference, then the genetic stability of the cell would be in danger.

On the other hand, it is also known that the information of viruses is completely transcribed by the ribosomes of the eukaryte cell. Why wouldn't then the genetic information carried by male gametes be just as well transcribed by the ovum?

7. Functional hemizygozity in homozygotes?

The principle of exclusion is favourable to the heterozygous state. It follows from this that:

(A) The amphibious (dioecia) plants and animals are heterozygotes, the homozygotes cannot live.

(B) The monoecious xenogam is a real diploid plant, in population it is heterozygous.

(C) In case of the autogamic plants, homozygous descendant-series are formed by self-pollination continued through generations. In the course of the artificial inbreeding, many traits are broken and perish by turning to the homozygous state because the homologuous chromosomes become more and more similar to one another.

The "clear traits" that have endured inbreeding for 4 to 6 generations in a comparatively constant state (degeneration stops), survive in a homozygous state through long series of generations.

On this basis anybody might say: in the living world the fermion-boson state is forced, Pauli's principle has nothing to do with the genetic system of species because in the homozygous state there are even two identical forces of which just one "would be too many".

In respect of number, we accept the objection. But if we suppose that "one of these forces took a vow to remain entirely or partly silent" — then Pauli's principle is valid.

From the principle of exclusion, the supposition follows unambigously that one of the members of the homologous chromosome pair (paternal or maternal) accidentally becomes genetically inactivated. That is to say, the inbred strait is structurally homozygous but functionally hemizygous. The genetic inactivation, developed in the course of imbreeding, is supposedly characterized by the following.

(a) Heterozygotes have in one of the members of the homologous chromosome pair A_1, and in the other A_2 isoenzyme genes. For instance, in case of two active gene pairs: A_1A_2, B_1B_2.

In case of an ideal hybrid vigor every gene has its different pair.

(b) After self-fertilization more and more homologous chromosome pairs enter into new combinations and in them the gene pairs will be identical. In every identical gene pair (allelic pair) one of the genes becomes inactive. This is the cause of the debilitation of inbred traits.

(c) The genetic inactivation is irreversible and incidental and takes place either in the paternal or in the maternal chromosome.

(d) Genetic inactivity can only be solved by xeno-fertilization (the complimentary gene).

(e) The inactivation of chromosomes cannot be traced by the staining processes, carried out until now. It may, however, be traced by radioautography.

8. The origin of sexuality

The cause and importance of sexual polarization has not been cleared up by biology, as yet. The general opinion is that sex is the speciality of the living world and its "sense" is recombination, serving defence and development against the phenomena of decay.

CORRENS (1928), for instance, emphasizes that bisexual potency is the elementary property of living beings. The contrary opinion is represented by GÁNTI (1977) who emphasizes that sexuality cannot be considered as a generaly characteristic property of living systems because parasexuality is to be observed in procariotes, as well, and even that is not general. We are indebted to Professor P. GREGUSS (1965) for beginning to look for the cause of sexual polarization in the inanimated world. Greguss considers sexuality as a law of nature and reduces its origin to the attraction between the contrast pairs in the inanimate world: "+" and "−" electricity, "acids and bases".

But we had soon to discover that these contrast pairs cannot be the movers of development. If, namely, an electron (e^-) and a positron (e^+) collide, their masses transform into radiation. And when the electron meets a proton (p^+), a hydrogen atom is formed. On the other hand, from the point of view of the living world, the existence of composed atoms is of decisive importance. But in the creation of these the main part is played not by the electromagnetic interaction but by nuclear forces.

The "contrast of acids-bases" has little to do with DNA-formation. Our opinion took shape (9 years ago) in this way. It essentially agrees with the conception of SCHROEDINGER (1951): that the "secret" of living beings, the essence of their organization are to be looked for in the laws of quantum mechanics.

We are convinced that the origin of the mono- and bisexual structures of the cell leads us into the world of subatomic particles. On the basis of our former paper (1978), we do emphasize the following:

1. In the construction of the composed atomic nuclei it is decisively important that two different fermions (proton and neutron) of approximately identical masses and identical baryon charges form an interlinked system in the same quantum state. This is the first bivalent dichotomy (boson state) at the level of the atomic nucleus.
2. In the formation of atomic nuclei, the alternation of the fermion and boson states can be observed.
3. In the formation of the living world, the peculiar construction of the pure boson atoms: C^{12}, N^{14}, O^{16} is determinative.
4. Pauli's principle, based on the connection between spin and symmetry classes, is valid not only for the elementary particles but also for the composed systems formed of the formers.

(A) At prokaryotes, the "fermion" and "boson" states manifest themselves at molecular level. The double-stranded DNA of bacteria, blue-green algae reflects bivalent parity and one of the strands reflects the "fermion" state. Bacteria are, therefore, molecularly diploid.

The free occurring molecular haploids are the RNA and the single-stranded DNA viruses. A number of the double-stranded DNA viruses are supposedly template asymmetrical and, therefore, functionally fermions. It was demonstrated about T_7 phages that the transcription of the mRNA takes place in 99 per cent only from the minus chain. SUMMERS&SZYBALSKI (1968).

(B) The uni- and bilateral character in the eukaryotic cell presents itself at chromosome level. As the chromosome — opposite to one of the chains of the DNA — is representative in itself, too, in case of Protozoa the fermion peculiarity appears in two separate (+ and −) haploid cells. The separation enables the genome (fermion, entity), marked with "+" and "−" characters, to unite. At molecular level, the fermion-boson state changes in a single cell, at chromosome level, however, in separate haploid and diploid cells.

In the interaction of the two different fermions (+, − genomes) two tendencies prevail: On the one hand, they form a strictly linked boson system, on the other hand, they manifest themselves in a comparatively independent form. These are substantially two different degrees of restriction. A strong restriction is, e.g., the hermaphroditic state, a weak one is amphibiousness (dioecia). The fermions "becoming independent" appear in the vegetable kingdom, in the different forms of sexual polarization.

(a) At unicellulars, the sexual character manifests itself only at the level of gametes.

(b) In algae and ferns, the sexual polarization primarily presents itself in gametes and the prothallium.

(c) In case of seedy plants, it already extends over the sporophyton, as well.

The final state of sexual polarization is, in every case, the appearance of emphibious character, the real diploid chromosome number, and the sexual chromosomes. The formation of differentiated sex chromosomes is necessarily tied with the amphibious property.

Male heterogamy has two forms: 2A+XY (mammals); 2A+XO (Protenor type), and similarly, female digamy has also two: A+ZW (Anas type); 2A+ZO (Lymantria). FALUDI (1961). Chromosomes X and Y can participate in different extent in determining sex but the essence is, in each of these cases (XY, YO), that the odd sex chromosomes carry the whole individual into a fermion state.

Social Hymenoptera have no sex chromosomes. In these, the oddness of autosomes, the haploid partogenesis of the male individual lead to sex polarization. The harmonized social activity of the diploid workers of eusocial ants, bees, wasps is made possible by their boson state.

The homogamous XX and ZZ individuals similarly represent a boson state, in respect of their chromosomes; but functionally they are fermions.

In case of mammals, it is known from the investigations of MARY LYON (1961) and RUSSELL (1963) that one member of the XX chromosome, which determines the female sex, becomes inactive in an early phase of embryogenesis.

In the full separation of the two sexes is, therefore, decisive that the genes (or most of them) of the sex chromosomes have no allel or that is inactive.

In this way, the fermion state gets on a higher level, the male and female individuals leave the hermaphroditic restriction but these individuals carry both sexes in their autosomes.

* * *

The editorial board has considered some statements of the monograph as disputable but it agrees to publishing it.

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IMPORTANCE OF PROTOZOA IN THE DYNAMIC CHANGES OF THE RHIZOSPHERE

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Abstract

The autor tries to determine on the basis of his earlier and more recent findings the role of 282 species of protozoa demonstrated from the rhizosphere in the dynamic processes at the surface of the roots (rhizoplane) and around the roots. The population of the rhizosphere by microorganisms, as well as the role of the various factors are demonstrated by experiments. The migration, distribution, quantitative and qualitative changes of the protozoa and the interactions of the various factors are dealt with.

Introduction

It was scarcely one and a half centuries ago that EHRENBERG (1837) demonstrated active protozoa from soil on which he poured water. Following this besides the bacteria the protozoa of the soil also came into the limelight. In spite of this, it was only in 1952 that the finding valid for bacteria (HILTNER, 1904) that the organisms are much more abudant in the soil around the roots of the plants than farther away from them could be proven for the protozoa too (BICZÓK, 1953). The concept of the rhizosphere was born; by this the soil zone influenced by the microflora was understood (HILTNER, 1904). As "the coexistence between the plants and the microorganisms living in the soil can be best observed in the living-space next to the roots" (FEHÉR, 1954), this zone could be regarded as the rhizosphere. The boundary of this is determined by the range of action of the root secretion or the bacteria induced by it. Within this an outer and an inner rhizosphere and a root surface or rhizoplane are recently distinguished (ROVIRA and DAVEY, 1974). It is impossible to draw a boundary between these because the biocoenosis of this sub-biotope is an open system, in which the microorganisms, the root secretion and the complex abiotic factors are in an intricate interaction, and thus often bring about important changes in relatively short time. In these dynamic changes the protozoa have their own place, role, and importance. In the following we try to discuss this problem mainly on the basis of laboratory experiments with the purpose of suggesting useful ideas to researchers working in this field.

Materials and Methods

There are no reliable methods for the investigation of the soils and within them of the microorganisms of the rhizosphere. Cholodny's method (1934) modified by ROSSI (on sterile slides placed in vertical soil slits protozoa besides bacteria and fungi can be observed after two weeks after suitable staining, washing and drying) is rough and the species are not easily identifiable. This method

gives no information just on the microorganisms of the root surface in the rhizosphere. Brodsky's method (1937) (an 8 mm diameter and 35 mm long glass tube filled with wool soaked with hay brew and sunk into the soil) was, owing to the afore-mentioned causes, not reliable. We deemed it better to introduce the end pieces of the root under examination into a 5 cm long, vertically placed vial, in which the sterile water was closed by cotton-wool. On the 6–8 cm deep roots of the pea a small number of *Oicomaonas mutabilis, Bodo* sp., *Amoeba beryllifera, Euglypha alveolata, Hartmanella hyalina, Colpoda cucullus, C. inflata, C. steinii,* on the roots of the strawberry *Oicomonas termo, Amoeba botryllis, A. fasciculata, Diaphanosoma arcuata* and *Colpoda inflata* were identified. The finding drew attention to the importance of the rhizoplane and the necessity of the use of laboratory methods.

The essence of the laboratory methods used by the present author was described earlier (Biczók, 1953–1959). Among them an important role is given to direct procedures, continuous investigations of the various cultures. In order to approach some basic problems the autor often turned to the study of active and cysted protozoa inoculated into sterile soils and living in an ambiance soaked by root extract. The O_2 consumption near the rhizosphere, around the roots and the O_2 consumption of the roots themselves influenced by the microorganisms were measured by the conventional Warburg technicque. Thus valuable comparable data were collected concerning the differences in the activity of the different parts. The results were expressed by time unit per gram values in/ul.

The direct methods are highly appreciated even today. In addition to their relatively high value they can be used even now with the smallest error percentage. This is why Rovira and Davey (1974) emphasize that direct examination of the roots by light microscope provides valuable information for the understanding of the ecology of the microorganisms of the rhizoplane. One such method is that of Geltzer (1961). The method is based on joint raising of plants and soil microorganisms on glass plates covered with a film of organic medium.

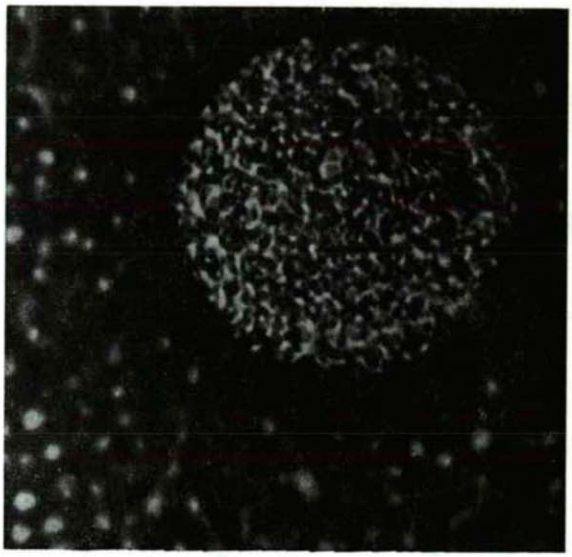
Quantitative investigation of the microorganisms of the soil is a very difficult task. Cutler's method worked out in the twenties, is still used for this purpose (Darbyshire, 1966). The active protozoa of the sample were killed by 2% hydrochloric acid. The number of remaining cysts was subtracted from the total number of protozoa and this gave the number of active protozoa. For the liberation of the microorganisms adhering to the soil particles and roots usually mechanical methods are used (Singh, 1955). Singh's method was modified by Darbyshire (1966), who shook the samples for 5 minutes at 20°C in an incubator shaker. According to my observations such a procedure activated a large number of the cysts (Biczók, 1957) and this throws doubt on the value of the method. For studying the interactions of the microorganisms we often use bacteriumcultures into which protozoa have been inoculated. Using negative nigrosine staining and taking into consideration the amount of water escaping on drying, we got to know not only the quantitative conditions, but also the morphology of the microorganisms of the culture (Figs. 1a and b). Part ot the Hypotricha protozoa, however perish. Their number and quality must be checked by direcf examination of the culture, by fixing and staining methods.

Results and conclusions

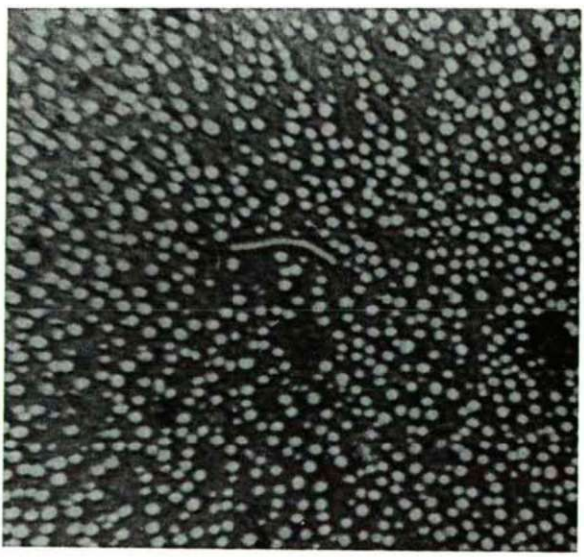
1. Development of the rhizosphere

The development of the rhizosphere is a subject which involves many disputable questions, at least as concerns the protozoa. This is partly due to the fact that the research of the infusoria of the rhizosphere has but a short history, although in recent times more and more researchers turn to the research of these (Biczók, 1952–1965; Darbishyre, 1966; Decheva, 1966; Decloitre, 1975; Geltzer, 1961; 1963; Nikoljuk, 1956; 1968; Rovira, and Davey, 1974; Varga, 1958 etc).

There are three approaches to the problem. (a) Analysis of the 282 species of protozoa of the rhizosphere (66 species of flagellates, 106 species of rhysopods and 110 species of ciliates) demonstrated by me. (b) Examination of the microorganism of the seeds that find their way into the soil. (c) Inoculation of soil and fresh-water protozoa into steril soil and studying of their behavior.



a



b

Fig. 1. Microorganisms in the root extract of (a) *Oenothera biennis* and (b) *Aristolochia clematiti* on the 12-th day (In Fig. b encysting *Colpoda fastigata*. Negative nigrosine staining).

Of the flagellates the following were most frequent and numerous in the rhizosphere of the different plants: *Bodo edax, B. globosus, Oicomonas mutabilis, O. termo* and *Scytomonas pusilla.* Of the rhysopods: *Amoeba gorgonia, A. verrucosa, Dactylosphaerium radiosum, Vahlkampfia limax, Naegleria gruberi, Cryptodifflugia oviformis, Euglypha alveolata, E. laevis, Sphenoderia dentata, Trinema enchelis, T. lineare.* Of the ciliates: *Colpoda cucullus, C. fastigata, C. inflata, C. steinii, Glaucoma scintillans, Platiophrya lata, Uronema marinum, Cyclidium glaucoma.*

The species listed above can be found among the 250 species demonstrated from the soil by SANDON (1927) as well as among the soil-dwelling species found by VARGA. Although several researchers consider the unicellular organisms that occur here soil-dwellers ("Bodenbewohnenden"; LEMINGER 1972), we must suppose that a considerable part of the protozoon population of the soil comes from other biotopes (46% i.e. almost one half of the 282 species live in decayed matter, waters rich in bacteria and pools and only 18% of them are known from the soil). It is very probable that adaptation through thousands of years has made it possible for most of these species to be active in the soil for shorter or longer time. First of all the good many species listed above come into question. It must, however, be taken into consideration, that most of the protozoa have a wide ecological valence. *Colpoda cucullus* and steinii for example thrives well in the antarctic region (SUDZUKI and SHIMOIZUMI, 1957), *Cyclidium glaucoma* in waters of 41–51 °C temperature (ISSEL, 1910), *Euglypha alveolata* in dirty waters very poor in O_2 (LACKEY, 1938) and *Cyclidium glaucoma* in media made almost anaerobic by a gas binding O_2 (NIKITINSKY, 1930). But it must also be taken into consideration that the protozoa active in the rhizosphere are also exposed to stress effects, which in the course of millions of years have led to cyst formation. The protozoa that could not develop this ability are completely absent in the sub-biotope discussed here. Besides VARGA others also emphasized as a possibility of adaptation that the protozoa in the soil are smaller than those in fresh water (KEVAN, 1972). We must also be aware of the fact that active and in cultures encysted protozoa isolated from the rhizoplanes thrive in the culture liquid, and there are considerable differences of size between members of the successive generations.

From the point of view of the development of the rhizosphere it is important that the seeds which get into soil, e.g. the wheat grain, carry a large mass of microorganisms with them (BICZÓK, 1956). The majority of the cultured species are known from the soil and the rhizosphere. On the other hand the phytoflagellates were nearly completely lacking. This fact suggested that the seeds were infected from the soil. SZABÓ (1968) made similar investigations on the microbial level with seeds of *Robinia pseudacacia.* According to his investigations infection took place already in the hull. The picked seeds were infected wit bacteria depending on the circumstances and part of these bacteria have nothing to do with the rhizoplane flora. Root symbiotes may occur among them; the others die in the soil.

More convincing proofs could be expected from the inoculation of the protozoa into sterile soils. I carried out several such investigations.

(a) From a *Colpoda fastigata* clone culture taken from the soil I transferred cysts together bacteria to different sterile soils or more axactly into a hollow made in the middle of their surface. The soil samples closed in by glass plates were saturated with root bren from below. It appeared that the activated animals passed through the 3.5 cm thick garden soil in 8 days, through the 4.5 cm thick layer in

10 days, and trough 12 and 18 cm thick layers in 31 and 35 days respectively. Their movement in the soil became observable after fixation with a mixture of sublimate: formalin (9:1) of the active (partly encysted) forms which adhered to the glass plates when they were taken out periodically. Thus not only the movement, but also the great proliferation of the protozoa in the soil became evident. The active state gradually decreased, but lasted several months. The dynamic movements and changes of state appeared as functions of the changes of the bacteria.

(b) The inoculated materials stemmed from the culture of moss from sodic soil and from the plankton of a small pond near Szeged. The sterile garden soil filtered both materials and selected their microorganisms. The results of these investigations are remarkable. The protozoa isolated from the moss, the small pond and the rhizosphere significantly differed from each other. On the other hand the species (part of which could not be demonstrated in active form either from the moss or from the pond) passing through the sterile soil and demonstrable from the culture liquid or the glass plates are those that are well known from the rhizosphere (Those activated from moss: *Oicomonas termo, Bodo globosus, Bodo* sp., *Naegleria gruberi, Dimastigamoeba soli, Vahlkampfia limax, Colpoda maupasi, C. steinii, Trichopelma sphagnetorum.* From the water of the pond: *Bodo* sp., *Cercobodo* sp., *Oicomonas termo, Naegleria gruberi, Cyclidium glaucoma, Tetrahymena pyriformis, Colpoda steinii,* and some *Hypotricha*).

These methods can be refined (in soil filtrates, with known mono- or polybacterial material using several glass plates). Even so it can be determined which protozoa are nearest to the true soil-dwelling protozoa or are just those (euedafic) and which are not those (euriedafic). Besides this, they show the possible dispersion or proliferation of the protozoa in the rhizosphere. The spreading of the microorganisms in time, which is demonstrable at the bottom of the experimental vessels and on the glass plates, is regular. This regularity can be expressed by the quotient of the distance covered in the soil (S) and the time needed for it (T) (BICZÓK, 1959). In my opinion the earlier term diffusion quotient (DQ) should more correctly be changed to dispersion quotient:

$$DQ = S/T$$

This formula depends on many factors (the structure, water content, temperature, O_2 content of the soil, the presence of material from roots, the amount and composition of the microorganisms, etc). According to my experiments made so far, this applies to both horizontal and vertical dispersion, which excludes among others such a supposition that the migrating gravitational water or solutions could have a decisive role in the penetration of the microorganisms into the soil and their appearance in the rhizoplane.

2. The Rhizosphere Effect

In the research of the rhizosphere the study of the microorganisms of the rhizoplane is in the centre. This is where most bacteria, protozoa and fungi live, metabolism, material and energy exchange are most active. The basis of this is expressed by Katznelson's R/S ratio (1946), which is nothing else than the quotient of the number of microbes in the rhizosphere (R) and in the soil outside the former (S).

In the case of wheat this is 4:1. This quotient can evidently be applied to the protozoa as well. In a closer approach such a connection may be sought between the microorganisms washed off from the roots together with particles of soil and the microorganisms firmly adhering to roots. The latter group is much richer. This is why investigation of the rhizoplane studying of its fauna, is a thankful task (BICZÓK, 1956).

The rhizosphere effect manifests itself most clearly perhaps trough the root secretions, as these are the primary energy source for the microbes and partly the protozoa, too, for according to the findings of various authors, in the exudate of *Triticum aestivum* for example 11 kinds of sugar, 19 different kinds of amino acids, 10 organic acids, 3 nucleotides, flavone and just as many enzymes can be found. Part of these are important in the maintenance of exenic cultures. The amount, quality and balance of the substances mentioned vary according to the plant species, but also according to age. But the exudative substances of the rotting, decaying roots or root cells also change. In older plants the coline of the roots is an important substance (e.g. in the *Bromus*) as it inhibits the growth of microorganisms. It is possible that such an inhibitor — like substance is the explanation of the great difference between the protozoon populations of the young wheat roots and the stubble — field root cultures: Table 1.

Table 1

	Young wheat roots	Stubble-field wheat roots
Flagellates	1,244,500	12,200
Rhysopods	88,717	640
Ciliates	1,364	247 per cu cm

The major processes (allelopathy) induced by the substances excreted by the plant roots play directly or indirectly (first of all through the bacteria) a regulatory role in many respects in the rhizosphere. On the basis of observations made on protozoon cultures of root extracts, which may be regarded as crude models, this conclusion can be drawn (BICZÓK, 1955b). Fig. 2 shows the complex interactions taking place in root extract of Colpoda fastigata from which it is not difficult to read out the stimulating and inhibiting effects, the function of inhibitors which in certain cultures cause massive encystment. Perhaps this makes it understandable why there are so many cysts in the rhyzoplane, why the cultures of carefully washed roots are repopulated so soon and contain — even though temporarily — a large number of microorganism species and individuals.

Encystment is in many respect a function of the rhizosphere effect. It is a process which take place not with clocklike regularity. It is the result of stress exercised by the presence of damaging factors, the depletion or lack of substances essential for life. The cysted state is lasting protection against these (protective cyst) but in part of the cyst it also means reproduction (reproductive cyst). Preservation of the species is thus better ensured. This kind of reproduction is common in the soil, and always results in smaller forms. We must think of this when we bring up as argument for the soil-dwelling nature of certain protozoa the fact that they are smaller-sized than usual (KEVAN, 1962).

Cystment is a result of soil-dwelling way of life and it is not impossible that it

was evolved to a higher level by the rhizosphere effect. Therefore species incapable of developing a cyst are absent in the soil, the rhizoplane. It might be mentioned in addition that encystment occurs also in the culture liquids; dilution of the culture liquids leads to excystment (The concentration of damaging substances is decreased). Root extracts often cause excystment. From this it follows that the periodicity of cystment is not necessary; it only seems to be so because the evoking factors occur periodically in certain cases.

From the effect of the root extract their specificity could be inferred (1955b) and the fact that the exudates of the roots differ from species to species of plants and thus also the microflora and therefore the protozoon populations of the rhizosphere of different plant species too. Fig. 2 justifies this conclusion. More convincing was the fact that in the rhizosphere in sterile soil of different, mutually infected seeds significantly different protozoon faunas developed.

3. The quantity and quality of the protozoa in the rhizosphere

The importance of the rhizosphere effect can be assessed by the quantitative and qualitative composition of the protozoa; by the complex processes in which besides the bacteria and protozoa with a smaller but not negligible number of species and individuals the fungi (HEAL, 1963), nematodes (ANDRÁSSY, 1953), rotatoria, occasionally acarina, tardigrada and algae (NOVICOVA, 1968), take part.

The members of the rhizosphere coenosis are in constant interaction. It is difficult to gain an insight into the complex chain of these interactions because it contains as its components physical and chemical factors of the soil, meteorological as well as biological effects.

Among the chemical factors I mention the pH examined also by myself because its extreme values are a serious limiting factor for the microorganisms. According to LACKEY (1938) *Pleuromonas jaculans* can bear even a pH 2.2-, *Actynophrys* a pH 3-, *Chlamidomonas* and *Urostrycha* a pH 1.8. In my laboratory some protozoa of the rhizosphere (e.g. *Amoeba verrucosa, Trinema lineare*) could bear even the strongly alkaline value of 10, but more of them tolerated the acid pH 4 (*Vahlkampfia limax, Trinema enchelis,* the *Colpoda,* especially the *fastigata* and *steinii* species, as well as *Tachiosoma pellionella* and *Trichopelma sphagnetorum*). According to my observations the majority of the flagellates tolerated these extreme values well. The findings of VARGA (1933) indicate narrover limits of tolerance.

Besides the pH the water content, the O_2 and the temperature are important factors of the dynamic processes of the rhizosphere. These are factors that precondition each other. Our finding that in the lower-lying wet area of the meadow examined by us the number of one-celled organisms is very small, that there are half as many testacea as in the higherlying areas (BICZÓK, 1954; 1955a) practically means that the O_2-consuming decay processes have become increased in this area. Frequent water covering is anyway unfavourable from the point of view of soil respiration, just as much as a higher temperature, which reduces the O_2 of the soil and at the same time increases the O_2 demand of the microorganisms. It is true that 25% of our 106 rhizopods demonstrated from the rhizosphere are satisfied also with less O_2, 21% of them also with O_2 in traces, 17% 110 ciliates has a decreased O_2 demand, 11% of them are near to the anaerobic state, yet the above-mentioned variation is not indifferent because many species may die or encysted.

Meteorological influences play an important role in the quantitative and qualitative development of the protozoa. The classical investigations of KISS (1951) clearly proved the weather — sensitivity of the neuston and seston organisms: the fact that the swarming of certain microorganisms, their increased vegetative and reproduktive processes take place under prefront influence, and the ionization following radiation and electric effects play an important role in this. The proliferation of microorganisms in the rainwater pools in the town of Szeged was interpreted similarly by GELEI and SZABADOS (1950). We have also pointed out this phenomenon in connection with the rhizosphere of the wheat (Fig. 3). There we described not only the development of the proliferation, but also the fluctuation and succession phenomena, as well as the nutrition biological aspects of the various populations (BICZÓK, 1953; 1956).

The major seasonal changes in the number of the protozoa are of a different character. Accordind to HEAL (1964) a maximum of the quantity of the moss — inhabiting testacea can be observed between May and October. In the case of the protozoa of the soil, the maximum number was reached in November and December; from then on the March there was a sharply decreasing tendency, then in August there was a new maximum (FEHÉR and VARGA, 1944). In the rhizosphere of the wheat the number of the protozoa was highest in November; then their number increased again in January and April. The causer of it is understandabla: the condition in November after germination is favourable for microbial activity, and so is early spring. The summer minimum is a sign of a decrease in root activity.

Many dynamic changes are connected with the peculiar character of the relationship between the bacteria and the protozoa. 40% of the 282 kinds of protozoa found in the rhizosphere eat only bacteria. Nearly as many eat other things, but also bacteria. We may therefore rightly say that "bacteria find favourable conditions for development in the rhizosphere, where they reproduce intensively and where they attract protozoa" (GELTZER, 1963). There are bacteriologists who under — estimate this problem, all the more because in comparison with the enormous number of the microbes the number of the protozoa is insignificant in the rhizosphere. But for example a single ciliate is many times larger than a bacterium. This makes their presence important. An example may be the generally 63 μ long cylindrical swarmer of *Pyxidium asymmetricum* nov.sp. found in the rhizoplane (BICZÓK, 1956). The animal and its spindle — like digesting vacuola could well be modelled, and so on the basis of the consumption of bacteria observed under oil immersion we found that in a day it consumed 60,000 bacteria and in approximately a week nearly 400,000, which corresponded to the volume or mass of the animal.

Studying of the bacteria — protozoa relationship produced many theoretical suppositions and experimental facts, which were completed by the investigation of the role of fungi. Connected with these investigations is the finding that there is an inverse relationship between the number of the protozoa and that of the bacteria (CUTLER and SANDON, 1921). This seems to be influenced by some phenomena. e.g. where the microscopic fungi, actinomycetes were abudant, the development of the amoebas was inhibited (GELTZER, 1963). These fungi and certain bacteria have often a protistocidic, sometimes a stimulating effect (GELTZER, 1969). It seems that the bacteria effect the development of the protozoa: *Azotobacter chroococcum* influences them intensively, the nitrifiers less strongly, the cellulose decomposers very slightly, the ammonifiers not at all (NIKOLJUK, 1963). With this is connected

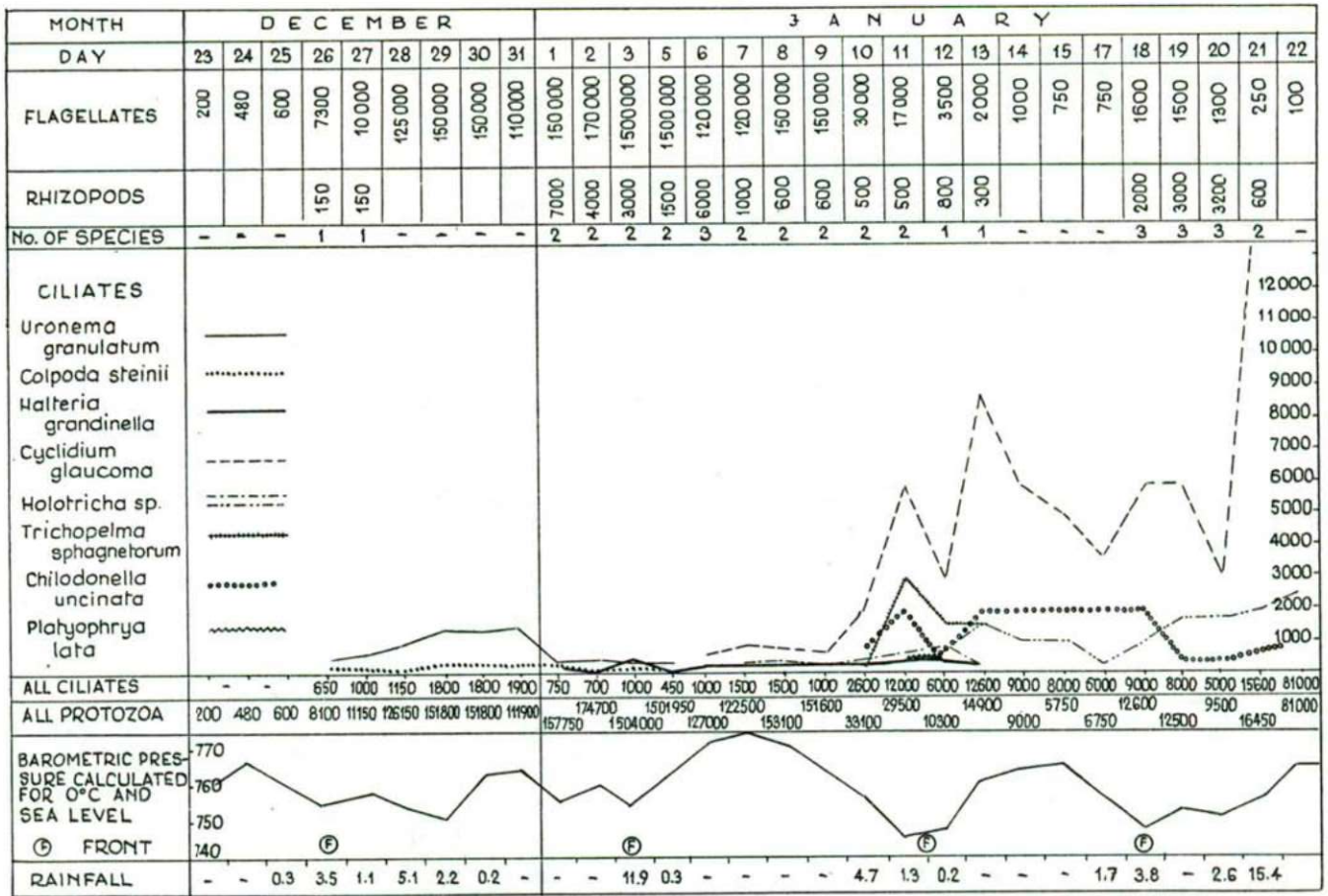


Fig. 3. Quantitative and qualitative changes in protozoa of the rhizosphere of the wheat caused by meteorological influence in December 1951 and January 1952.

the fact that the amoebas digest certain bacteriaw ith ease, others with difficulty (SINGH, 1941). Similar is the situation with certain ciliates (BURBANCK, 1942).

The inhibitions and stimulations resulting from the mutual influences can be followed by the observation of the increase (TELEGDI—KOVÁTS, 1932) or decrease of the CO_2 production, just as the carbon-dioxide production gives information on the activity of the microorganisms in the soil. This is why we investigated the O_2 consumption of the rhizoplane, the soil next to it, and the soil outside the rhizosphere (expressing 1 hour's consumption in μl/g) between 1969 and 1972. It was found that the average consumption of the soil outside the rhizosphere was 2.4 μl, that of the soil next to the roots 3.1 μl, and that of the rhizoplane 38.5 μl/g. The results show clearly why we must concentrate our attention on the research of the rhizoplane. It is worth while to mention that the minimum of consumption was observed in August and December, its maximum in June. This is not connected with the seasonal change of the amount of the microorganisms.

4. The Effect of the Protozoa on plants

Among the complex mutual influences a central question is that influence the protozoa exercise on the roots or the whole plant. This is the most difficult and least cleared question. It is a reasonable supposition that by eating bacteria that are harmful for the development of plants the protozoa influence the development of plants (IWAO HINO, 1926). This is just as barren a hypothesis as that of RUSSEL and HUTCHINSONS' (1909), according to which the infusoria accumulating in soil considerably reduce the population of bacteria, and this results in tiring of the soil. The number of the protozoa is small for this, and the active state of the majority of them is of shorter duration than that of the bacteria. The presumable effect of the metabolites of the protozoa (GELLÉRT, 1958) their soil-preparing role the direct influence of their biologically active substances on the plants (NIKOLJUK, 1954) are questions that deserve further research. But those species, indicators must also be investigated on the basis of which the influence of the protozoa on the plants appears. It is noteworthy that the rhizoplane sometimes contains very many cysts, sometimes chiefly around erosions; it is possible that certain active forms are parasites of the roots.

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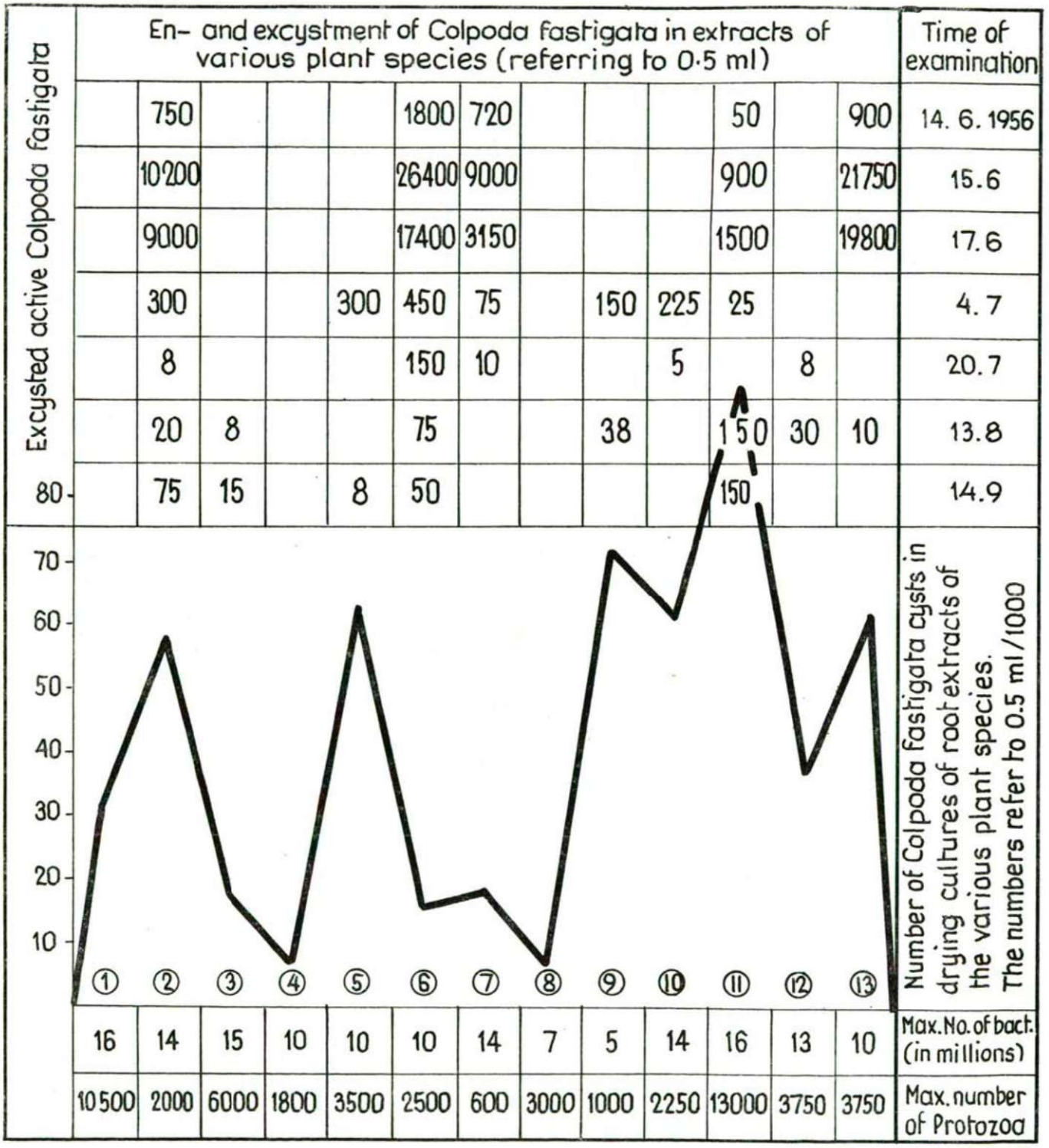

Fig. 2. Cystment of Colpoda fastigata in extracts of various plant species. Explanation: Root extracts of *Achillea millefolium* (1), *Allium angulosum* (2), *Aristolochia clematitis* (3), *Datura strammonium* (4), *Cichorium intybus* (5), *Daucus carota* (6), *Mentha longifolia* (7), *Ononis spinosa* (8), *Nonea pulla* (9), *Reseda lutea* (10), *Salvia nemorosa* (11), *Solanum dulcamare* (12), *Verbena offcinalis* (13).

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ELECTRON-MICROSCOPICAL STRUCTURE OF GILL LAMELLAE OF THE IDE (LEUCISCUS IDUS), WITH PARTICULAR REGARD TO THE CHLORIDE CELLS AND H_2S POLLUTION

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Abstract

The respiratory epithelial cells of the gill lamellae of the ide form a double layer. Under the superficial respiratory epithelium, chloride cells are to be found in great numbers. The structural elements of the two types of cells are very different. In the chloride cells, in addition to the few rough endoplasmic reticula, there are many smooth endoplasmic reticula which probably carry out the tasks of osmoregulation. The exocytotic activity of the superficial respiratory epithelium indicates the secretory role of the gill epithelium. The damage caused by H_2S is connected with the multiplication of lysosomes and dense bodies and, at a higher concentration, H_2S results in a large amount of membrane accumulation.

Introduction

We have investigated the effect of water polution on the gills of fresh-water bony fishes for some years now. The gill apparatus of sea-fishes has also been investigated by STAMMER and VÁMOS (1973), STAMMER, HORVÁTH and CSOKNYA (1977), the gill innervation mainly by STAMMER (1966). Lately, we have also much studied the fresh-water fishes of the Tisza, using material chosen for comparison, not only with a light microscope but also with an electron microscope (STAMMER, 1972; STAMMER and HORVÁTH, 1975). The gill epithelium seems to be particularly suitable for measuring water pollution. The natural pollution, and artificial pollution with hydrogen sulphide, as well as the effect of Dikonirt 4, were examined on the organelles of epithelial cells of the gill. As a result of the harmful impact, changes in the appearance and number of lysosomes, as well as the occurence of membrane configurations and membrane fusions can be shown, connected mainly with the destruction of mitochondria.

Recently investigation into an interesting fish species, the ide, became important. Its highly developed chloride cells indicate the marine origin of the species.

Materials and Methods

8–10 cm long selected individuals of 7–9 g weight of the ide have been used for as the material for investigation. The ide is rather rare in our rivers. Thus in the Tisza it can only be fished in large quantity at the time of migration. Its most characteristic external feature is its colour. This changes greatly in the individual, depending on its age, the season and the habitat. Among our lakes, it can only be found in those of deep water, and then only exceptionally. As its main nourishment consists of insects, snails, shell-fish, and other tiny animals living on the bottom, as well as plankton, we may assume its gill respiration is satisfied by the oxygen present in deep waters. Here the water has a higher pressure and a lesser pollutin effect.

1 cm pieces of the laminae from the dissected gill apparatus were studied, in longitudinal sections, after being fixed by Bouin's method or in formalin, with routine tissue staining and impregnation. The material for the electron-microscopic examinations was cut into pieces 0.6 mm in diameter, fixed in osmium and embedded, in araldite. The sections were made with a Tesla BS 478 ultramicrotome and were examined visually with a Tesla BS 500 electron microscope.

After studying normal histological structure, by light and electron microscopy, we examined the damaging effect of H_2S on the organelles of the respiratory epithelial cells animals that were kept in water filled of 1, 2 and 3 ppt H_2S. We were able to observe reversible damage only in the case of 1 ppt H_2S.

Results

The well-developed branchial arches (four and a greatly reduced fifth arch) of the ide, *Leuciscus idus* like those in a number of other species belonging to its family — are furnished with 2 lateral gill plates with many respiratory lamellae regularly opposite one another. The gill plates having supporting elements rounded connective tissue with blood vessels and nerve fibres. In the base of the branchial arch arteries can be found in the lateral plates, running in the middle with copious primary and secondary ramifications divided into capillaries (Fig. 1). The capillaries are covered by gill epithelial cells.

Respiratory epithelial cells

Under a light microscope, we see that the respiratory epithelial cells seem to be in only a single layer under a light microscope, unlike those of the fishes examined previously. But it becomes clear even from semi-thin sections (Fig. 1) that this in only a pseudo-single layer. Under the very thin epithelium layer cuboidal epithelial cells of comparatively large size are visible. Beside the round and frequently indented nuclei of the latter cells, the longish nuclei of the superficial flattened respiratory epithelial cells are scarcely distinguishable. In the course of our comparative studies on the gill plates of fresh-water fishes, we could never distinguish (under the superficial, flattened, respiratory epithelial cells) chloride cells (acido-or osmophilic cells) in as great a number as in this species.

Chloride cells have already been described from both invertebrates and vertebrates. Cells of this type were described in publications by HUGHES and GRINSTOM (1959), DOYLE and GORECKI (1966), MORGAN (1968), NEUSTEAD (1972), PHILPOTT and COPELAND (1960), HAUSTON (1964) and TREADGOLD (1972).

The flattened respiratory endothelial cells which cover the surface adhere close together in a line of waves, without any desmosomal connection. In the cell, the endoplasmic reticulum is very weakly developed but some scattered ribosomes can be observed free in the cytoplasm. No Golgi apparatus was found. In the cell, there are few mitochondria and these are of the cristate type. The limiting membrane of the cell surface is larger than the thickness of a unit membrane (120–230 Å) and several exo-or endocytotic vesicles are connected with it. The nucleus of the surface cells is longish and never indented.

The nucleus of the chloride cells is round with a deep intussusception and sometimes one small one in addition. The number of mitochondria is fairly large; their form is round. It is noteworthy that they belong to the mitochondrion with tubular type (Figs. 2–3). Apart from the rough endoplasmic reticulum of the chloride cells,

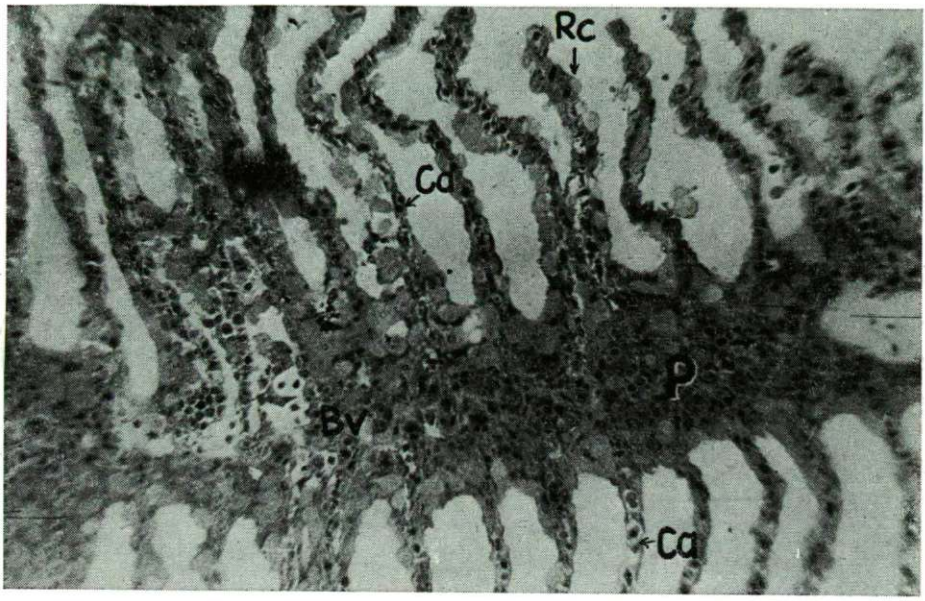

Fig. 1. *Leuciscus idus:* Section of the first gill plate with respiratory lamellae. H_2S damage came from below and removed the respiratory epithelial cells. Bv=arterioles of the lateral plates Ca — capillaries, Rc = respiratory epithelial cells, P = section of gill plate. Toluidine-blue staining, semi-thin section: x800.

a very large number of pieces of smooth endoplasmic reticulum can be observed. It is probable that the ide, as strongly euryhaline organism, transferred its habitat from seawater to fresh water. Accomodating itself easily to the change in salt concentration, it has become adapted to the new conditions, retaining the large number of chloride cells which presumably play, an important role in osmoregulation and, possibly, also in transporting oxygen to its blood vessels. Particular attention should be paid to the large space between the chloride cell and the arteriole of the gill, to be seen in the picture (Fig. 2). The steep gap filled cytoplasmic matrix between the membrane of the chloride cell and the wall of the arteriole may serve for draining of the osmotic products of the chloride cell.

The tubuli of the mitochondrion and the cisternae of the endoplasmic reticulum become wider as a result of the effect of low H_2S. The increase in membrane density can be seen particularly well in Fig. 3, and the tubular structure of the mitochondria in Fig. 4, which are electron micrographs from high magnification.

Apart from the role of the superficial respiratory epithelium in absorbing the oxygen and forwarding it to the blood vessels, the excretory function of the cell is to be particularly emphasized. It has been known since Krogh's investigations (1941) that the hyperosmotic fluid leaves bony sea-fishes through the gill epithelium. It is possible that this phenomenon cannot be observed in fresh-water species. In the present species, however, the respiratory epithelium has retained this capacity. This is proved by the detached vesicles of remarkably large size (300 Å in diameter). Vesicles like this may remove excretory matter, in solution as well as osmotic fluids.

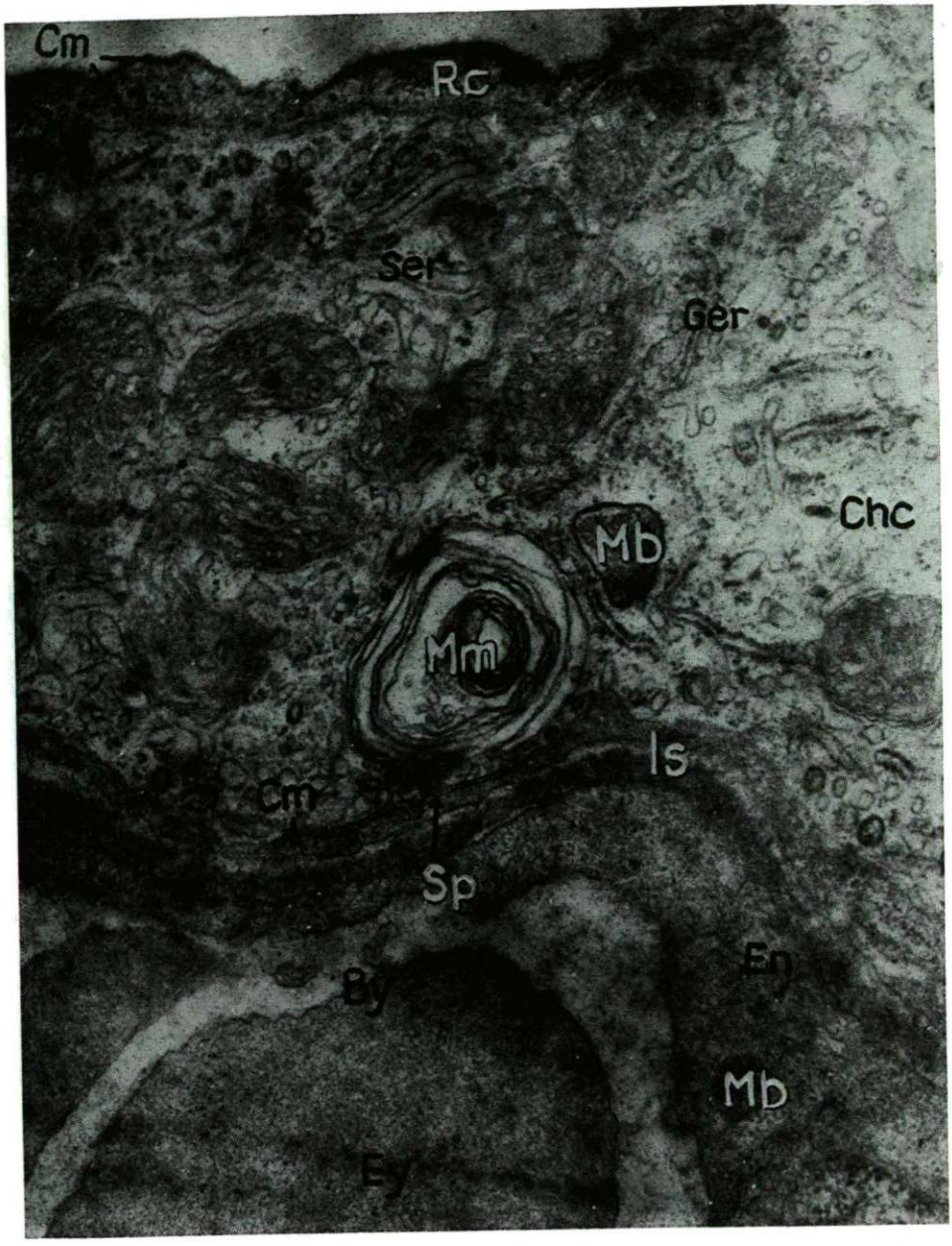

Fig. 2. *Leuciscus idus:* Cross-section of gill lamellae. Rc = respiratory epithelial cell, Chc = chloride cell, By = capillary, Ey = part of erthrocyte, En = part of endothelial cell, Ser = smooth endoplasmic reticulum, Ger = rough endoplasmic reticulum, Mm = membrane configuration, Cm = cell membrane, Is = cytoplasmic matrix, Sp = medial gap, Mb = granular body. Electron micrograph: x28 000.

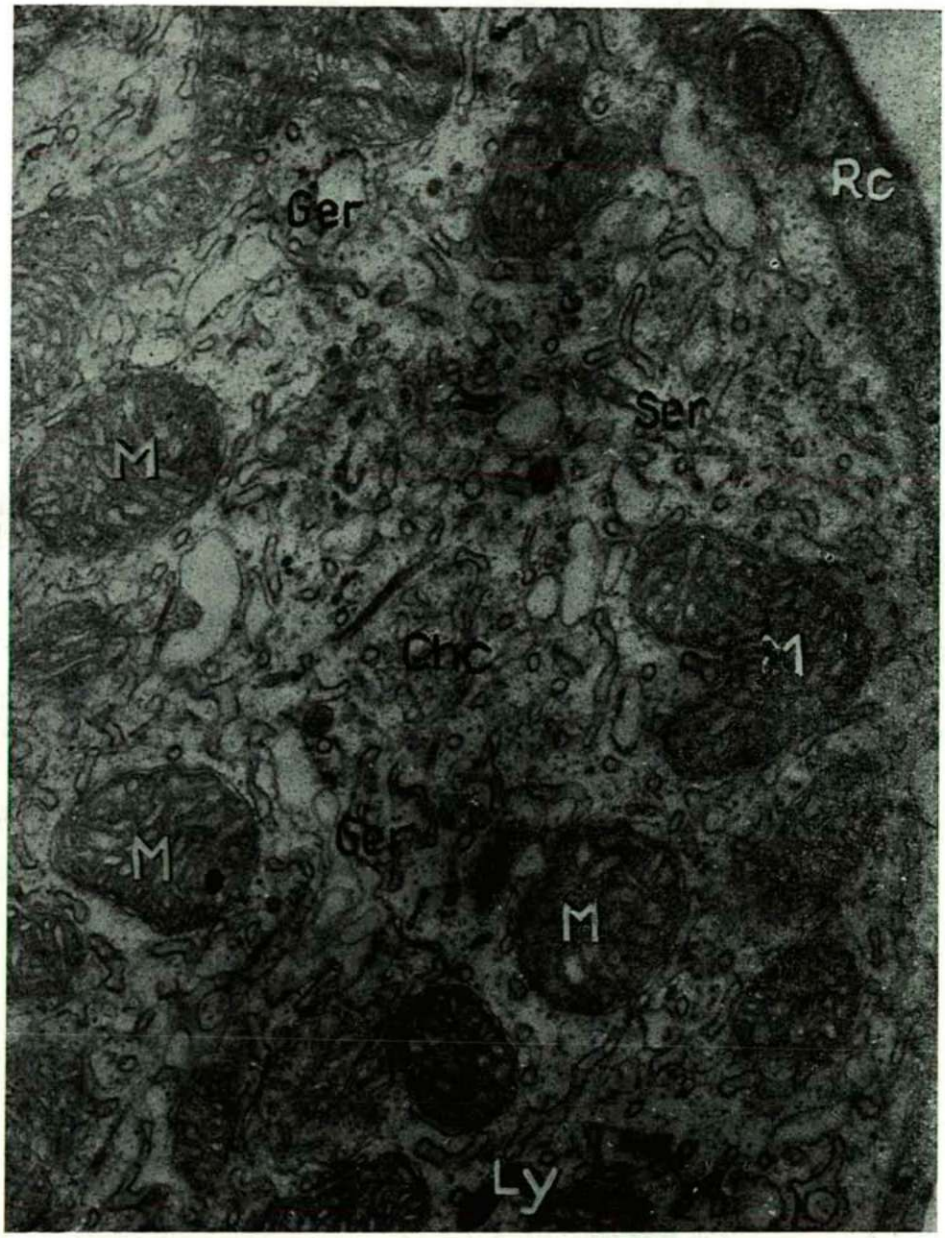

Fig. 3. *Leuciscus idus:* Cross-section of a gill lamellae. Respiratory epithelial cells. Rc = respiratory epithelium, Chc = chloride cell, Ser = smooth endoplasmic reticulum, M = tubular mitochondrion, Ly = lysosome. Electron micrograph: x28 000.

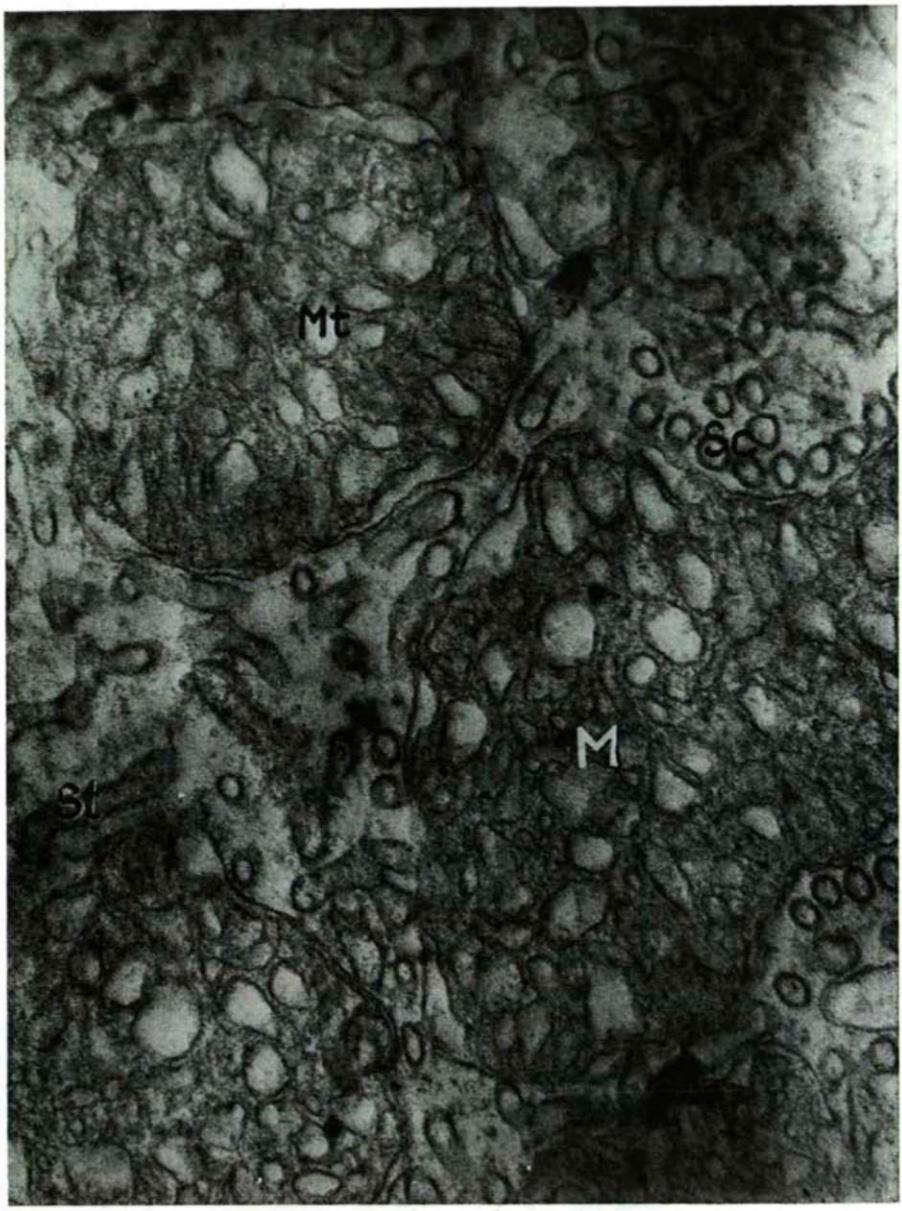

Fig. 4. Mitochondria with cross sected tubuli in the chloride cell. M = mitochondrion, Mt = mitochondrial tubulus, St = cisterna of the smooth endoplasmic reticulum, Sc = cross-sections of the smooth endoplasmic reticulum. Electron micrograph: x64 000.

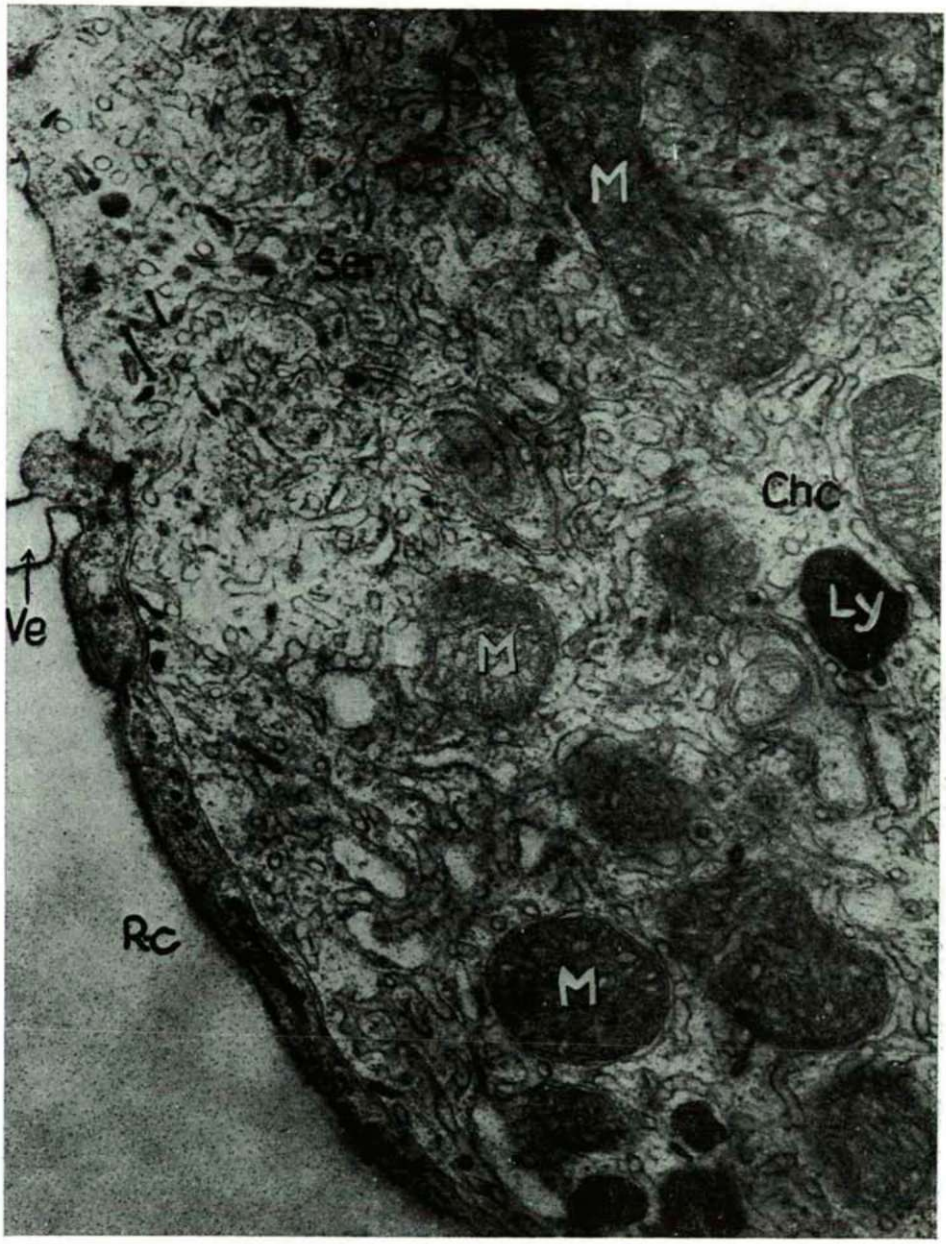

Fig. 5. *Leuciscus idus:* Respiratory epithelium with exocytotic veiscles and the structure of a chloride cell. Rc = respiratory epithelium, Chc = chloride cell, Ve = detached vesicle, M = mitochondrion, Ser = smooth endoplasmic reticulum, Ly = lysosome. Electron micrograph: x28 000.

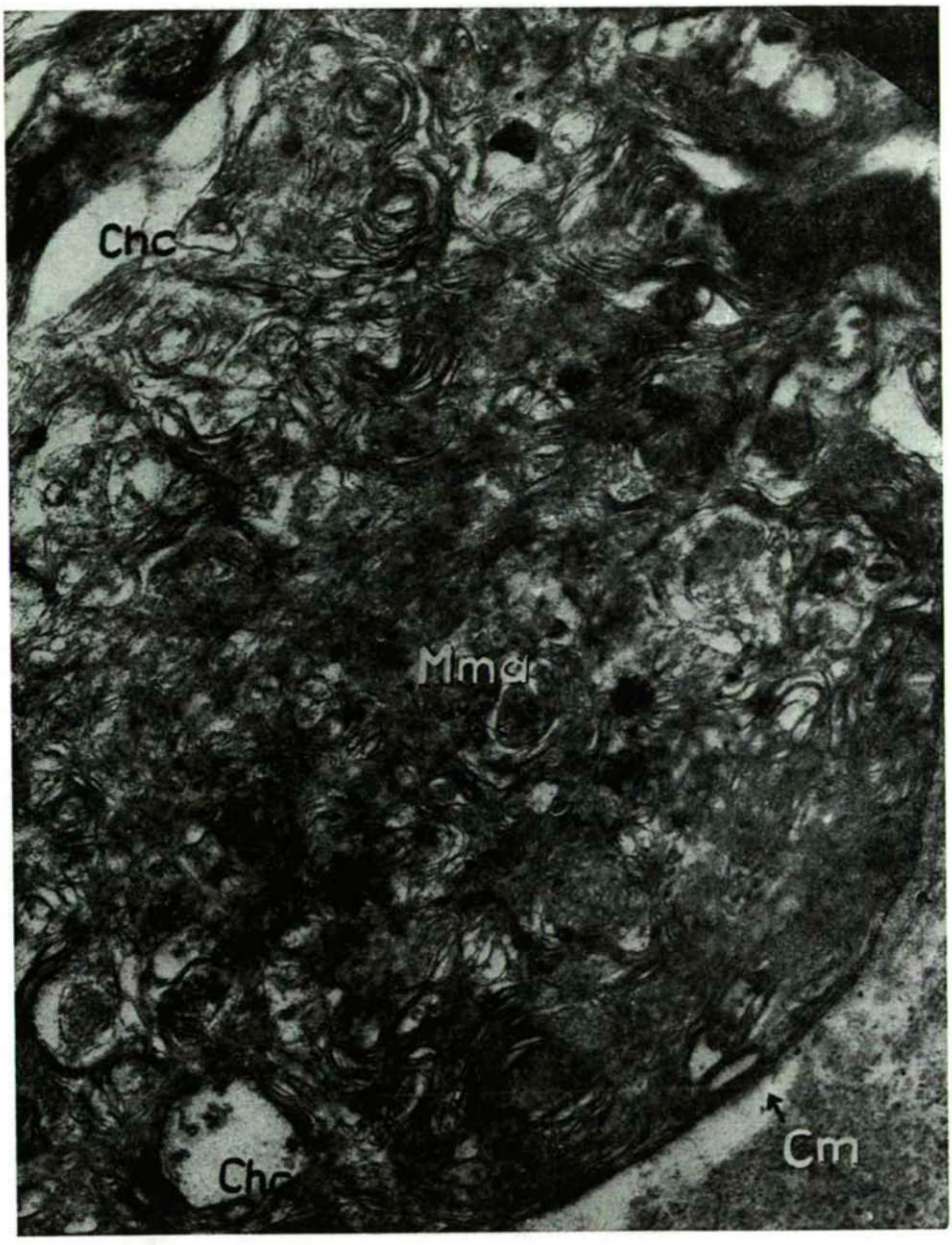

Fig. 6. *Leuciscus idus:* Irreversible damage to a chloride cell. Damage caused by 3 ppt H_2S. Chc = chloride cell cytoplasm, Mma = membrane agglomerate, Cm = cell membrane. Electron micrograph: x28 000.

Damaging effects of H_2S

The effect of H_2S used in different concentrations caused different changes in the organelles of the gill epithelial cells and their physiological function, as demonstrated by the photomicrographs. H_2S left hardly any marks at the lowest concentration used. At higher concentration (0.6–1 ppt) the membrane density of the endoplasmic reticulum becomes darker, the cysterna of endoplasmic reticulum larger, the mitochondrial tubules or cristae become more visible caused by stronger electron-density. As a result of exposure, the membrane configuration (Fig. 2) and a smaller or larger functioning lysosome appeared (Figs. 3–5).

As a result of exposure to 2 ppt H_2S, both types of respiratory epithelial cell become detached. The detachment can apparently be seen in our semi-thin section (Fig. 1). In this, the hydrogen sulphide, coming from below entirely detached, from one side, the epithelial cells covering the surface of capillaries. Among the gill cells, the respiratory epithelial cells in particular are very prone to detachment. This in also proved by our figure (Fig. 5) in which respiratory epithelial cells can no longer be observed in the upper part of the picture. The chloride cells perish and become detached from the outer surface of the capillary only after the detachment of the respiratory epithelial cells. Influenced by H_2S, the double cell membrane between the respiratory epithelial cell (and the chloride epithelial cell) becomes denser and the gap between the membrane of the chloride cell and the capillary becomes wider.

The effect of H_2S, tested at the highest concentration (3 ppt), caused the irreversible merging of all the membrane systems of the chloride cell. The bulk of these membranes derive from the mitochondrial membranes (Fig. 6).

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DIE KÖRPERLICHE ENTWICKLUNG DER KINDER VON BÉKÉS

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Auszug

Vom Autor wurden Körpergrösse, Körpergewicht und Brustumfang bei ruhigem Atmen von 1095 Knaben und 977 Mädchen der Stadt Békés (Komitat Békés, Ungarn) bestimmt. Ferner wurde der Brustumfang bei Inspiration und Exspiration der Jugendlichen über 7 Jahre gemessen und daraus der Atmungsausschlag berechnet. Angaben bezüglich der Erscheinung der Menarche wurden von 592 Mädchen gesammelt.

Die Parameter der Angabensammlung sind nach Altersgruppen und Geschlechtern in Tabellen angeführt.

Es wurde festgestellt, dass drei — körperliche Entwicklung bestimmende — Merkmale der Kinder stark variieren, den Parametern der Kinder aus der ähnlich grossen, gleichfalls im Komitat Békés gelegenen Stadt Gyoma, sowie auch den Budapester Parametern der Jahre 1968/1969 im allgemeinen nachstehen.

Die Menarche-Mediane kommt dem Landeswert nahe (13,094).

Einleitung

Bis jetzt wurde die anthropologische Untersuchung der körperlichen Entwicklung der ungarländischen Kinder von zahlreichen Autoren bereits bei vielen Siedlungen durchgeführt. Man verfügt über ziemlich viele Angaben, es kamen sogar umfassende, synthetisierende Studien heraus. Ungeachtet dessen gibt es dennoch Gebiete, von denen wenig Informationen vorliegen. Solch eine geographische Einheit stellt auch die Gegend links der Theiss dar. In dieser Gegend werden vom Anthropologischen Institut der Attila József-Universität seit mehreren Jahren Datenerhebungen zur Erkennung der erwachsenen Bevölkerung angestellt und dabei wurden auch die notwendigen anthropologischen Masse zur Beurteilung der körperlichen Entwicklung der Kinder gesammelt. Zuletzt kam es in der 22 357 Einwohner zählenden Stadt Békés (Komitat Békés) zu solchen Angabensammlungen, worüber in dieser datenliefernden Studie berichtet werden soll.

Material und Methode

Die drei Merkmale zur Bestimmung der körperlichen Entwicklung — Körpergrösse, Körpergewicht und Brustumfang bei ruhigem Atmen — wurden in der Zeit von 6. bis 18. Februar 1978 bei 1095 Knaben und 976 Mädchen festgelegt. In die Untersuchung wurden die Jugendlichen im Alter von 3 bis 18,5 Jahren einbezogen. Weiterhin wurde der Brustumfang bei Inspiration und auch bei Exspiration gemessen, da aber die Abnahme dieser Masse bei Kindern im Kindergarten-Alter schwierig ist, wurden diese nur bei den Schulkindern (919 Knaben und 805 Mädchen) festgestellt.

Beim Messen trugen die Mädchen Turntrikots, die Knaben — Turnhosen. Wegen des wechselnden — vor- und nachmittäglichen — Unterrichtes konnten die Messungen nicht nur auf Vormittag oder Nachmittag beschränkt werden.

Zur Untersuchung wurden Anthropometer, Stahlbandmass und Federwaage verwendet. Bei Ersteren wurden die Ergebnisse der Messung mit mm-, bei Letzterem mit einer Genaugkeit von 10 dkg festgestellt. Die Aufnahmen erfolgten nach Martins Technik.

Zur Festellung der physiologischen Reife wurden Beobachtungsblätter von 592 Mädchen im Alter von 10 bis 19 Jahren ausgefüllt.

Die Messung und Sammlung von Angaben nahmen stets die selben Personen mit gleichem Aufgabenbereich vor.

Untersuchungsergebnisse

Bevor auf die Bewertung der erhaltenen Resultate eingegangen wird, sei zunächst untersucht, inwiefern unsere Stichprobe für die Ausgangspopulation, gegebenenfalls für die Kinder von Békés im Alter von 3 bis 18,5 Jahren repräsentativ ist.

Laut jüngster statistischer Angaben (Békés megye..., 1978) zählt die Stadt Békés 790 Kinder im Kindergarten-Alter. Die Zahl der von uns untersuchten 3—6,5 jährigen Kinder beträgt 347, d. i. 43,9% unserer Ausgangspopulation. Die unteren Klassenzüge der Grundschule zählten 1195 Schulkinder. Im Alter von 7 bis 10,5 Jahren wurden 481 Kinder unserer Untersuchung unterworfen, dies entspricht 40,3%. Schliesslich beträgt die Schülerzahl der oberen Klassenzüge 995, die Zahl der 11—14 jährigen in unserer Stichprobe ist 756, d. h. 76,0% aller Schulkinder der oberen Klassenzüge war an unserer Untersuchung beteiligt. Bezüglich der Mittelschüler liegen uns keine eindeutig vergleichenden Angaben vor, lediglich soviel, dass die einzige Mittelschule von 463 Schülern besucht wird, jedoch diese Zahl ist nicht identisch mit der der gleichaltrigen Kinder von Békés.

Es ist also ersichtlich, dass unsere Stichprobe bei den einzelnen Altersgruppen zwischen 40 und 76% schwankt, d. h. ihrer Grösse nach dazu geeignet, um aus ihr auf die Ausgangsgesamtheit Schlussfolgerungen ziehen zu können. Unabhängig davon muss jedoch bemerkt werden, dass diese relativen Häufigkeiten nicht als absoluter Wert betrachtet werden dürfen, da es sowohl in der ersten Klasse des unteren —, als auch in der achten Klasse des oberen Klassenzuges der Grundschule ältere Kinder gibt, deren Anzahl uns nicht bekannt ist. Eine bedeutende Abweichung zwischen der erhaltenen relativen Häufigkeit und der wahren Verteilung darf jedoch nicht vermutet werden.

Die Ergebnisse der Untersuchung sind in den Tabellen 1—7. zusammengefasst. In den Tabellen 1—6. wurden Körpergrösse, Körpergewicht, Brustumfang bei ruhigem Atmen, Brustumfang bei Inspiration und Exspiration, sowie die unter Berücksichtigung der beiden letzteren berechneten Parameter der Atmungsausschlages nach halbjährigen Altersgruppen und Geschlechtern angeführt. In den Tabellen wurden angegeben die Zahl der Einzelbeobachtungen nach Altersgruppen (n), die Variationsbreite (w), der arithmetische Durchschnitt ($\bar{x}$), sowie die Streuung (s). In der Tabelle 7. wurden Grundangaben der Menarche zusammengefasst.

In den Altersgruppen von 18,5 Jahren ist die Zahl der Einzelbeobachtungen in den Tabellen so klein, dass diese nicht bewertet werden können.

Aufgrund der Ergebnisse geht hervor, dass sich die Durchschnitte — wie natürlich auch zu erwarten — abgesehen von ein-zwei Fällen monoton erhöhen. Zur gleichen Zeit finden sich Altersgruppen, bei denen die Durchschnitte im Vergleich

zum vorangehenden Lebensjahr niedriger sind. Kleinere Abweichungen bewirken keine besonderen Probleme, da sich diese Anomalien in erster Linie aus der Grösse der Stichprobe ergeben. Es gibt jedoch auch Altersgruppen, wo grössere Abweichungen zu verzeichnen sind. Beispielsweise sind die 3,5 jährigen Knaben um 1,88 cm kleiner als die 3 jährigen. Das Körpergewicht der 16 jährigen Mädchen ist um mehr als 1 kg niedriger als das der um ein halbes Jahr jüngeren Altersgruppen. Der Brustumfang bei ruhigem Atmen der 18 jährigen Knaben ist um 1,1 cm kleiner als bei den 17,5 jährigen.

Alldas darf kaum durch Stichproben- oder Messfehler erklärt werden. Wahrscheinlich ergeben sich die Unterschiede in diesen Fällen aus den örtlichen Eigenarten der einzelnen Altersgruppen, eine nähere Erklärung kann jedoch momentan nicht gegeben werden.

Im Falle des Brustumfanges bei Inspiration kommt diese fallende Tendenz auch bei den 18 jährigen Knaben zur Geltung, indem ihr Brustumfang um 0,9 cm kleiner ist als der der 17,5 jährigen. Dies beweist von sich selbst, dass kein Messfehler vorliegen darf, denn so eine Abweichung liess sich auch beim Brustumfang bei ruhigem Atmen bekunden.

Sehr auffalend — mehr als 2 cm — beträgt der Unterschied des Brustumfanges bei Inspiration im Falle der 15,5—16 jährigen Mädchen. Bei den Mädchen, die die erste Klasse der Mittelschule besuchen, ist dieses unerwartete Ergebnis in erster Linie auf die unrichtige Technik der Respiration zurückzuführen. In ähnlicher Weise kann auch der um fast 1 cm kleinere Brustumfang bei Exspiration der 18 jährigen Knaben im Vergleich zu den 17,5 jährigen interpretiert werden.

Beachtenswert ist auch, dass bei Exspiration der Brustumfang der 16 jährigen Mädchen um 1,70 cm —, der der 18 jährigen um 1,48 cm kleiner ist als bei der vorangehenden Altersgruppe.

Unsere andere Möglichkeit zum Vergleich ergibt sich daraus, dass wir früher an einem anderen ebenfalls im Komitat Békés gelegenen Ort, in Gyoma auch ähnliche Angabensammlungen angestellt hatten (Farkas, 1975). Vergleicht man die Merkmalsdurchschnitte der Kinder beider Siedlungen — Békés und Gyoma —, so ist eine grosse Anzahl von Abweichungen festzustellen.

Bei den Durchschnitten in der Körpergrösse der Knaben sind diese Unterschiede nicht so auffallend, da solche Differenzen nur bei 9 von den 32 Altersgruppen der Knaben zu beobachten waren. Bei den Mädchen hingegen sind die Durchschnitte im Falle der 18 Altersgruppen kleiner als die der Mädchen ähnlichen Alters von Gyoma. Die Abweichungen sind im allgemeinen nicht wesentlich, erweisen sich lediglich bei ein-zwei Altersgruppen bedeutend wie beispielsweise im Falle der Knaben bei den 17,5 jährigen (mehr als 5 cm), im Falle der Mädchen bei den 13,5 jährigen (2,1 cm).

Wesentlich bedeutendere Abweichungen lassen sich dagegen im Körpergewicht finden. In Békés ist das Körpergewicht der Knaben in 16, das der Mädchen in 18 Altersgruppen kleiner als bei den Kindern von Gyoma. Der grösste Unterschied bekundete sich bei den 14,5 jährigen Mädchen, wo das Körpergewicht der Mädchen von Békés um 5,5 kg geringer war als das der von Gyoma.

Im Falle des Brustumfanges bei ruhigem Atmen sind die Durchschnitte im Vergleich zu den Kindern von Gyoma bei den Knaben in 20, bei den Mädchen in 18 Altersgruppen kleiner. Im bedeutenden Teil dieser sind die Unterschiede gleichfalls gering. Beachtenswert hingegen ist, dass besonders die 16—18 jährigen Jugend-

lichen einen bedeutenden Rückstand zeigen. Die Abweichung im Werte des Brustumfanges ist in erster Linie bei den Knaben zu beobachten, wo sie zwischen 2—10 cm variiert. Ähnlich verhält sich die Lage auch mit den Mädchen.

Dieser Vergleich ist jedoch in den höheren Altersgruppen (bei den 15,5—18,5 jährigen) nicht voll real, da die Stichprobe von Gyoma wenig Einzelbeobachtungen der erwähnten Altersgruppen enthält. Unabhängig davon darf behauptet werden, dass wenngleich die Abweichungen zwischen den Kindern der beiden Stichproben gleichen Geschlechts und gleicher Altersgruppe im grossen Teil der Fälle zum Nachteil der Kinder von Békés auch nachzuweisen sind, so wäre derem Grossteil wegen der so kleinen Differenzen statistisch nicht beweisbar. Der Umstand jedoch, dass die Durchschnitte beider Stichproben nicht identisch sind oder einander in grossem Masse nicht nahe kommen, obwohl es sich um annähernd gleichgrosse Siedlungen handelt, deutet dennoch an, dass die Kinder von Békés in ihrer Entwicklung im Vergleich zu den Kindern unter ähnlichen Lebesverhältnissen von Gyoma etwas zurückgeblieben sind.

Unsere dritte Möglichkeit zum Vergleich liefern die Budapester Durchschnitte aus den Jahren 1968/1969 (Eiben und Mitarbeiter, 1971). Aufgrund dessen erhalten wir — erwartungsgemäss — bei den Kindern von Békés im allgemeinen geringere Werte. Auffallend ist jedoch, dass im grössten Teil der Fälle bei beiden Geschlechtern im Mass des Brustumfanges bei ruhigem Atmen wesentliche Abweichungen zu verzeichnen sind. Der Brustumfang der Kinder von Békés fällt um 2—4 cm kleiner aus als der der Budapester ähnlichen Geschlechtes und Alters. Dergleichen grössere Unterschiede im Körpergewicht sind hauptsächlich in den höheren Altersgruppen der Mädchen zu beobachten. In der Körperhöhe erweist sich ein bedeutenderer Rückstand in den niedrigeren Altersgruppen der Mädchen von Békés.

Wie aus Tabelle 7. hervorgeht, wurden 592 Mädchen hinsichtlich des Auftretens der ersten Menstruation befragt. Das niedrigste Lebensjahr, in dem die Erscheinung auftrat, betrug 10,5 Jahre, während es im Alter von 15,5 Jahren praktisch bereits bei allen Mädchen zur Menstruation kam. Die Mediane wurde aufgrund der bei den Kindern von Gyoma verwendeten Formel errechnet und betrug 13,094 Jahre. Dies ist weniger als die frühere Landesmediane und gestaltete sich entsprechend den neuesten einheimischen Ergebnissen. Die dem Urbanisationsniveau der Stadt Békés entsprechende Schätzmediane liegt bei einem annähernden Wert von 13,11 Jahre.

Diese neueren Ergebnisse scheinen selbst zu bestätigen, dass der Bewegungsmangel im Falle der Kinder, die in einer verhältnismässigkleinen Stadt leben, weiterhin besteht und ihr Wachstum nicht so gleichmässig verläuft, wie dies die Lebensverhältnisse bedingten. Den auffalendsten Beweis hierfür liefern die Parameter des Atmungsausschlages, die davon zeugen, dass sich der Ausschlag des Brustumfanges, die Lungenerweiterung bei Knaben lediglich von 4 auf 7 cm, — bei Mädchen von 5 auf 8 cm erhöht. Diese Werte sind sehr niedrig besonders wenn man in Betracht zieht, dass der Zuwachs von etwa 2—3 cm in beinahe 11 Jahren erfolgt.

Tabelle 1. Parameter der Körpergrösse

Knaben				Lebensalter	Mädchen			
n	w	$\bar{x}$	s		n	w	$\bar{x}$	s
10	91,9—127,6	100,73	9,93	3	19	91,2—101,8	95,52	3,61
28	93,3—111,0	98,85	3,65	3,5	29	88,5—102,3	96,76	3,72
16	93,7—106,5	101,38	3,77	4	23	93,8—107,9	101,67	4,07
21	99,2—118,0	105,23	4,47	4,5	15	97,9—110,6	103,92	3,72
24	103,6—121,4	110,32	4,54	5	17	101,7—111,9	108,78	4,33
18	108,3—118,4	112,99	2,55	5,5	23	102,3—120,0	111,29	4,36
25	106,0—123,6	114,60	4,51	6	18	106,3—117,7	111,56	3,37
34	111,1—131,5	119,25	4,19	6,5	27	107,9—129,8	117,94	6,06
31	114,0—134,0	121,06	5,39	7	18	115,0—130,0	121,00	3,97
32	112,4—133,6	124,82	6,28	7,5	24	112,5—133,8	123,18	5,45
28	118,4—135,8	126,83	5,47	8	29	112,6—133,4	125,11	6,97
30	112,0—138,7	128,94	6,86	8,5	27	119,3—144,0	130,21	5,91
36	117,8—138,2	131,27	5,21	9	26	118,9—144,5	132,28	5,91
32	121,2—150,0	133,32	6,46	9,5	35	119,4—149,0	133,84	7,60
25	125,9—152,1	136,73	6,38	10	24	127,0—151,0	138,20	5,86
41	126,9—165,1	139,99	7,55	10,5	43	127,3—157,5	139,59	6,94
57	126,9—160,7	143,18	7,03	11	50	121,5—155,4	142,14	7,69
44	126,6—158,2	144,22	6,51	11,5	45	134,5—161,0	147,27	6,82
61	132,7—160,8	146,49	6,96	12	44	131,9—160,4	147,22	6,49
60	133,8—173,9	151,71	7,99	12,5	62	133,2—165,0	150,99	6,55
60	140,4—169,2	155,02	8,16	13	51	142,3—170,5	153,73	7,48
63	133,5—171,9	153,93	7,42	13,5	50	142,7—174,6	155,37	6,66
54	142,5—179,6	161,99	8,30	14	55	143,0—171,5	156,83	5,85
42	146,4—180,3	162,91	9,07	14,5	40	146,6—170,3	158,25	5,92
28	153,0—184,2	167,98	6,62	15	28	148,1—174,7	158,31	6,30
36	156,6—179,8	168,76	6,20	15,5	22	141,6—172,0	160,73	7,58
34	161,2—186,4	171,59	6,82	16	23	154,3—169,2	160,26	4,54
28	154,5—189,0	171,98	8,29	16,5	16	152,5—164,9	159,28	4,45
43	165,8—182,9	173,66	5,45	17	27	151,1—168,4	160,29	4,51
24	160,5—183,5	173,26	5,71	17,5	34	150,5—176,4	161,72	7,26
25	162,5—189,5	173,93	7,07	18	28	154,8—170,5	163,10	4,85
5	173,5—180,0	176,22	2,36	18,5	4	151,8—165,7	158,13	6,93
1095					976			

Tabelle 2. Parameter des Körpergewichts

Knaben				Lebensalter	Mädchen			
n	w	$\bar{x}$	s		n	w	$\bar{x}$	s
10	14,0—20,5	16,35	2,11	3,0	19	13,5—21,0	15,79	2,29
28	13,0—18,5	16,13	1,68	3,5	29	13,0—20,0	15,41	1,80
16	13,5—21,5	16,43	2,29	4,0	23	15,0—22,0	17,36	1,91
21	15,0—22,5	18,28	1,73	4,5	15	14,0—21,0	17,00	2,12
24	15,5—23,5	19,60	1,64	5,0	17	14,0—22,5	18,82	2,19
18	17,5—22,5	20,14	1,32	5,5	23	16,0—25,5	19,95	2,60
25	17,0—28,5	21,38	3,07	6,0	18	15,0—23,5	19,66	1,98
34	17,0—31,0	22,53	2,98	6,5	27	15,0—38,5	21,63	4,39
31	18,0—36,5	22,63	3,69	7,0	18	17,0—28,5	22,19	3,15
32	18,0—46,0	24,73	4,99	7,5	24	17,5—31,0	25,14	3,88
28	21,0—38,0	26,20	3,93	8,0	29	18,5—37,5	26,27	5,37
30	20,0—40,5	27,78	4,75	8,5	27	21,5—47,0	28,65	6,08
36	23,0—35,0	28,48	3,54	9,0	26	19,0—49,0	29,30	5,87
32	22,0—44,0	29,86	5,06	9,5	35	22,0—47,0	29,97	5,73
25	25,0—54,0	31,84	6,28	10,0	24	20,5—50,5	32,20	7,39
41	25,0—58,0	34,68	8,28	10,5	43	24,0—62,0	33,99	8,87
57	23,5—74,0	36,24	7,96	11,0	50	22,0—61,5	36,35	9,63
44	26,5—72,0	38,43	8,26	11,5	45	28,0—74,0	40,35	9,77
61	28,0—66,0	38,48	6,87	12,0	44	26,0—68,5	39,88	8,36
60	27,5—72,5	43,39	9,19	12,5	62	27,0—61,0	43,24	7,58
60	29,0—88,0	45,97	11,54	13,0	51	33,0—70,5	44,71	7,52
63	33,0—79,0	48,25	9,56	13,5	50	35,0—74,5	48,66	8,69
54	32,5—82,0	52,30	10,47	14,0	55	35,5—63,0	48,32	6,27
42	40,0—79,5	52,33	9,46	14,5	40	33,5—76,0	50,73	7,86
28	41,0—67,0	54,68	6,93	15,0	28	41,5—77,0	54,03	9,38
36	39,5—81,5	57,71	8,78	15,5	22	40,0—76,0	53,91	9,92
34	48,5—73,5	59,30	7,02	16,0	23	43,0—65,0	52,84	6,46
28	40,0—91,5	63,29	10,86	16,5	16	43,5—72,0	54,00	6,95
43	50,0—77,5	63,90	6,48	17,0	27	40,0—67,5	54,55	7,10
24	53,0—82,0	64,93	7,34	17,5	34	42,0—85,0	57,33	9,32
25	54,0—79,0	64,20	7,33	18,0	28	44,5—83,0	56,71	8,66
5	65,5—80,0	70,10	7,83	18,5	4	46,0—60,5	54,37	7,09
1095					976			

Tabelle 3. Parameter des Brustumfanges bei ruhigem Atmen

Knaben				Lebens-alter	Mädchen			
n	w	$\bar{x}$	s		n	w	$\bar{x}$	s
10	47,0—62,2	52,29	4,33	3,0	19	47,3—61,0	51,37	3,29
28	47,6—55,0	52,26	1,75	3,5	29	47,0—56,1	50,69	2,41
16	47,8—55,6	51,55	2,02	4,0	23	49,0—56,7	52,14	2,03
21	51,0—59,2	54,33	2,23	4,5	15	47,6—59,4	52,05	3,15
24	50,4—58,5	54,93	2,08	5,0	17	49,7—56,8	53,78	1,99
18	52,3—58,4	55,45	1,51	5,5	23	51,6—58,6	54,56	2,29
25	51,2—64,5	55,84	3,66	6,0	18	49,5—57,1	33,89	2,04
34	51,6—65,5	57,37	3,27	6,5	27	47,2—71,8	55,86	4,25
31	53,8—66,5	57,79	3,09	7,0	18	51,8—61,5	55,81	3,16
32	52,7—83,1	58,97	5,37	7,5	24	51,6—66,1	58,42	3,93
28	55,7—67,8	60,01	3,02	8,0	29	52,1—71,7	59,21	5,19
30	55,0—72,0	61,26	3,88	8,5	27	54,0—68,7	60,60	3,72
36	53,0—67,8	61,27	3,41	9,0	26	58,8—78,4	61,20	4,22
32	55,1—72,5	62,99	3,94	9,5	35	55,2—73,2	62,33	4,76
25	57,6—86,5	65,29	5,73	10,0	24	52,6—87,2	64,92	8,54
41	58,0—84,1	65,26	4,75	10,5	43	54,8—88,2	64,21	7,32
57	57,2—93,8	66,93	5,86	11,0	50	56,6—98,5	67,21	8,26
44	59,7—96,3	68,37	6,39	11,5	45	59,1—100,8	68,02	12,24
61	57,5—88,5	68,0	5,00	12,0	44	56,2—94,5	69,63	7,12
60	60,0—98,0	70,94	6,82	12,5	62	61,7—91,3	73,22	6,64
60	62,5—102,5	74,32	8,15	13,0	51	63,0—97,6	74,50	6,88
63	61,0—95,2	74,41	7,04	13,5	50	66,8—95,2	77,98	7,42
54	65,8—93,6	76,94	6,26	14,0	55	67,5—93,8	77,72	4,87
42	68,6—97,2	77,63	5,91	14,5	40	65,2—100,0	77,73	13,06
28	70,2—86,0	79,90	4,69	15,0	28	70,4—104,0	81,59	7,59
36	71,2—101,0	81,82	6,40	15,5	22	68,4—101,0	82,45	7,58
34	73,8—91,7	82,23	4,75	16,0	23	71,5—89,5	80,82	5,51
28	71,2—101,5	84,87	6,88	16,5	16	72,2—92,3	82,10	5,23
43	76,9—94,2	85,00	4,52	17,0	27	67,6—94,2	82,48	6,35
24	80,3—97,0	86,70	5,01	17,5	34	72,5—99,9	84,24	7,03
25	78,9—99,0	85,56	4,84	18,0	28	71,9—103,0	83,55	7,23
5	83,8—94,4	88,88	4,56	18,5	4	79,7—84,2	82,15	1,89
1095					976			

Tabelle 4. Parameter des Brustumfanges bei Inspiration

Knaben				Lebens-alter	Mädchen			
n	w	$\bar{x}$	s		n	w	$\bar{x}$	s
31	56,7—67,6	61,23	2,95	7,0	18	55,9—65,2	59,72	3,10
32	54,5—83,1	62,78	5,37	7,5	24	54,5—66,8	61,87	4,00
28	59,1—73,1	64,38	3,58	8,0	29	54,6—74,6	62,99	5,20
30	59,0—77,0	65,44	3,97	8,5	27	57,6—73,7	64,65	4,30
36	58,5—73,1	65,60	3,32	9,0	26	57,3—76,8	65,29	3,96
32	60,7—75,7	67,25	4,04	9,5	35	58,7—78,6	66,87	4,55
25	62,5—88,6	68,88	5,22	10,0	24	57,2—91,3	69,55	8,26
41	63,3—90,8	71,51	5,70	10,5	43	60,1—90,0	69,32	6,87
57	61,3—97,0	71,68	5,61	11,0	50	61,6—101,0	72,05	7,84
44	65,5—99,0	73,12	6,10	11,5	45	64,3—105,1	74,64	7,90
61	62,4—91,8	73,20	4,96	12,0	44	58,5—96,1	74,56	7,06
60	67,5—99,7	76,77	6,21	12,5	62	65,8—96,0	78,04	6,42
60	62,3—105,5	79,68	7,65	13,0	51	69,1—99,2	79,64	6,20
63	65,0—96,5	79,77	6,84	13,5	50	71,2—101,1	82,72	6,87
54	73,1—98,5	82,60	5,77	14,0	55	72,3—97,3	83,07	4,63
42	74,0—99,6	83,25	5,36	14,5	40	71,6—103,0	84,54	6,10
28	76,6—94,5	84,94	4,28	15,0	28	79,3—106,9	87,66	6,96
36	76,5—104,0	87,40	6,38	15,5	22	72,4—105,6	87,04	7,45
34	80,6—96,7	87,95	4,83	16,0	23	78,3—95,3	85,01	4,84
28	77,2—105,1	90,57	6,80	16,5	16	79,0—98,1	87,68	5,50
43	82,2—97,9	91,18	4,59	17,0	27	76,0—97,5	87,91	5,65
24	84,8—105,1	91,67	5,57	17,5	34	78,0—106,0	89,24	6,65
25	84,8—102,0	90,73	4,33	18,0	28	78,1—108,0	88,65	7,26
5	87,3—103,1	94,18	6,06	18,5	4	85,0—87,2	86,15	1,11
919					805			

Tabelle 5. Parameter des Brustumfanges bei Exspiration

Knaben				Lebens-alter	Mädchen			
n	w	$\bar{x}$	s		n	w	$\bar{x}$	s
31	52,1—65,6	57,05	3,02	7,0	18	51,2—60,4	54,89	2,97
32	52,5—80,5	58,33	5,06	7,5	24	50,1—61,0	57,23	3,99
28	55,1—66,4	59,03	2,82	8,0	29	50,9—70,5	58,10	5,12
30	54,5—70,0	60,40	3,68	8,5	27	53,0—68,0	59,54	3,73
36	52,5—66,6	60,27	3,36	9,0	26	51,7—70,6	60,27	4,02
32	55,0—70,0	61,90	3,90	9,5	35	54,2—71,1	60,45	3,96
25	56,4—83,5	63,19	5,61	10,0	24	51,8—84,4	63,44	7,99
41	57,7—84,2	65,44	5,90	10,5	43	55,5—84,8	62,77	6,53
57	56,4—90,5	65,86	5,53	11,0	50	54,5—95,2	65,28	7,80
44	60,0—93,2	67,22	6,14	11,5	45	58,1—97,8	67,68	7,83
61	56,1—86,3	67,27	4,95	12,0	44	54,9—92,1	67,60	6,82
60	59,7—97,0	70,04	6,72	12,5	62	59,7—87,0	70,97	6,10
60	62,3—100,8	72,99	7,64	13,0	51	62,6—93,1	72,26	6,27
63	60,1—93,8	73,68	7,10	13,5	50	64,3—91,8	75,61	6,96
54	64,2—92,2	75,96	6,07	14,0	55	65,6—92,1	95,20	4,93
42	66,6—91,2	76,25	5,41	14,5	40	63,7—97,2	77,14	6,23
28	69,6—84,9	78,36	4,54	15,0	28	70,0—101,0	78,91	7,23
36	69,1—98,5	80,29	6,17	15,5	22	66,4—100,0	79,55	7,24
34	73,0—89,4	81,18	4,17	16,0	23	69,8—85,0	77,85	4,89
28	69,5—96,4	83,53	6,58	16,5	16	71,0—89,6	79,01	4,53
43	76,6—92,5	83,73	4,10	17,0	27	66,9—90,0	80,05	6,22
24	78,3—96,0	84,64	4,82	17,5	34	70,2—97,5	82,23	7,13
25	75,6—90,5	83,66	3,86	18,0	28	70,2—105,0	80,75	7,61
5	82,4—92,9	87,04	4,18	18,5	4	77,0—81,0	79,28	1,77
919					805			

Tabelle 6. Parameter des Atmungsauschlages

Knaben				Lebens-alter	Mädchen			
n	w	$\bar{x}$	s		n	w	$\bar{x}$	s
31	0,6—7,0	4,45	1,27	7	18	2,5—8,8	4,83	1,26
32	2,0—6,4	4,61	1,21	7,5	24	3,7—6,7	4,87	0,90
28	3,4—9,1	5,41	1,28	8,0	29	2,8—7,4	4,89	1,07
30	2,9—7,0	4,95	1,25	8,5	27	2,3—8,3	5,29	1,20
36	2,7—7,9	5,36	1,20	9,0	26	2,3—8,0	5,06	1,39
32	3,2—7,7	5,34	1,10	9,5	35	4,5—9,1	6,56	1,02
25	3,1—7,9	5,76	1,11	10,0	24	3,9—7,7	6,11	0,94
41	4,1—10,5	6,16	1,48	10,5	43	2,6—9,8	6,51	1,52
57	3,7—10,0	6,00	1,15	11,0	50	4,2—10,5	6,80	1,47
44	3,1—8,7	6,13	1,41	11,5	45	4,2—9,8	6,83	1,13
61	3,6—9,9	6,11	1,32	12,0	44,	3,0—9,5	6,91	1,39
60	2,7—9,1	6,71	1,30	12,5	62	3,9—11,9	7,08	1,37
60	3,8—11,5	6,79	1,54	13,0	51	3,3—10,9	7,17	1,72
63	2,4—10,2	6,15	1,69	13,5	50	2,8—11,5	7,53	1,99
54	3,7—11,0	6,64	1,66	14,0	55	3,4—12,1	7,93	1,62
42	3,6—13,2	7,01	2,03	14,5	40	3,1—11,3	7,22	1,72
28	4,9—9,2	6,96	1,33	15,0	28	5,0—11,2	8,43	1,78
36	3,7—13,5	7,12	1,87	15,5	22	4,2—9,5	7,54	1,42
34	3,5—13,0	7,01	2,03	16,0	23	4,7—10,3	7,93	1,18
28	3,2—9,9	7,04	1,62	16,5	16	5,4—13,2	8,66	2,02
43	4,6—12,5	7,45	1,82	17,0	27	6,0—10,6	8,21	1,29
24	4,9—13,0	7,45	1,94	17,5	34	3,5—11,5	7,75	1,72
25	2,1—9,8	6,71	1,67	18,0	28	3,0—11,8	7,90	2,02
5	4,9—10,2	7,14	2,17	18,5	4	6,0—8,0	6,88	0,84
919					805			

Tabelle 7. Grundangaben über die Menarche

Lebensalter	Zusammen	Menstruierende		Nicht-menstruierende	
	n	n	%	n	%
10,0	1	0	0	1	100
10,5	27	1	3,70	26	96,29
11,0	47	1	2,12	46	97,87
11,5	44	3	6,81	41	93,18
12,0	44	4	9,09	40	90,90
12,5	50	16	32,00	34	68,00
13,0	57	28	49,12	29	50,87
13,5	44	27	61,36	17	38,63
14,0	45	33	73,33	12	26,66
14,5	34	31	91,17	3	8,82
15,0	30	29	96,66	1	3,33
15,5	22	22	100,00	—	—
16,0	22	22	100,00	—	—
16,5	22	22	100,00	—	—
17,0	32	32	100,00	—	—
17,5	30	30	100,00	—	—
18,0	31	31	100,00	—	—
18,5	9	9	100,00	—	—
19,0	1	1	100,00	—	—
	592	342		250	

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NOTICE: SIXTH SYMPOSIUM ON LIVING AND FOSSIL DIATOMS, BUDAPEST, HUNGARY. SEPTEMBER 1–6, 1980.

This is the first announcement for the Symposium on Living and Fossil Diatoms to be held on September 1–6, 1980 at the Hungarian Geological Society in Budapest, Hungary. Scientists working on the morphology, ecology, biostratigraphy and taxonomy of Living and Fossil Diatoms are invited to attend the symposium and to present papers or demonstrate their work. Deadline for abstracts, March 1, 1980. For preliminary registracion and submission of titles of contributed papers mail to Dr. Márta Hajós, Hungarian Geological Survey Budapest, Post Box, 106. Hungary 1442.

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